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CONSTRUCTING MONOLITHS FOR THE TYGART RIVER DAM, NEAR GRAFTON, W.VA.
An Army Engineer Corps Project Designed to Control Floods and Improve Navigation on the Monongahela River

Volume 6 — Number 9

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

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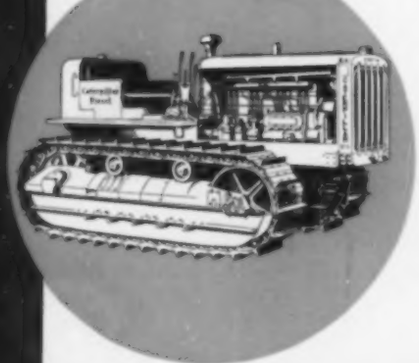

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VOLUME 6

NUMBER 9

Harlem River and Bronx Kills Lift Bridges

Many Novel Features Incorporated in Vertical-Lift Spans for the Triborough Bridge

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STRUCTURAL honesty combined with pleasing appearance is the fundamental principle embodied in the vertical-lift bridge constructed over the Harlem River and that designed for future erection at the Bronx Kills crossing, both integral parts of New York City's Triborough Bridge. A special effort was made to reduce the weights of these lift spans, as each has a deck area larger by far than that of any bridge of similar type previously constructed. This was accomplished by the adoption of a welded steel-plate floor with thin asphalt-plank wearing surface, by the almost exclusive use of silicon steel, and by placing all operating machinery on the towers. A novel arrangement of the auxiliary counterweight system has proved very efficient in operation. Pursuing an unusual method of erection, the general contractor assembled the Harlem lift span on barges, floated it into position between towers, and then raised it to pier level, where end panels were added and connections to counterweights made. Roadway floors and sidewalk surfaces were installed after the span had been elevated to its full height of 135 ft.

NAVIGATION requirements in the Harlem River and the Bronx Kills suggested the need for two vertical-lift bridges over these waterways, as a part of New York City's new Triborough Bridge. A description of the Triborough Bridge project as a whole, written by E. Warren Bowden, M. Am. Soc. C.E., assistant to the chief engineer of the Triborough Bridge Authority, appeared in the August 1936 issue of CIVIL ENGINEERING. Navigation on the Harlem River is quite heavy, though consisting largely of tugs and barges in tow. Bronx Kills is not now navigable, but a tide lock and ship channel are contemplated through the Kills in the future, connecting the Harlem more directly with Long Island Sound. High-level bridges at these locations would have been very costly and would have created difficult approach problems both in the Manhattan and Bronx areas. Water traffic does not require high-level bridges at these points, but on the other hand low-level bridges are not possible without imposing great burdens on both water and bridge traffic.

In view of these conditions, minimum underclearances of 55 ft for the Harlem River channel and 52 ft 6 in. for the Bronx Kills channel were adopted, with movable spans to provide an underclearance of 135 ft for water traffic when required. The lengths of the proposed channel spans dictated the adoption of vertical-lift spans, the Harlem River crossing to be constructed with such a span and the Bronx Kills crossing to be built with a fixed channel span that can readily be converted into a lift span if future water traffic should warrant it. To coordinate present and future parts and to simplify future operations, detailed plans and specifications were prepared for the future vertical-lift bridge as well as for the present fixed bridge over the Bronx Kills. The present channel span may be converted into a lift span by the addition of lifting girders at each end and a few other simple structural changes. The towers for the future lift span, resembling closely the Harlem Bridge towers, will replace the ornamental concrete towers now on the piers.

These are the first vertical-lift bridges in New York City. Because of their location and the general character of the Triborough Bridge project, appearance was considered highly important, and there was close cooperation between the engineers and the architects to secure a pleasing result. Utility and structural honesty were considered to be fundamental, while pleasing appearance was obtained through proper proportioning of parts, careful bracing arrangements, and appropriate treatment of machinery housings.

TABLE I. COMPARING SOME LARGE VERTICAL-LIFT HIGHWAY SPANS

NAME OF STRUCTURE	FLOOR TYPE	SPAN LENGTH Ft	ROADWAY WIDTH Ft	ROADWAY FLOOR AREA Sq Ft	TOTAL AREA OF SPAN Sq Ft	WEIGHT OF LIFT SPAN Lb
Bronx Kills, New York, N.Y.	Steel plate	350	90.71	31,000	39,500	5,850,000
Harlem River, New York, N.Y.	Steel plate	310	70.71	21,900	28,800	4,100,000
Hudson River, Albany, N.Y.	Concrete	341	42	14,000	20,000	5,430,000
Delaware River, Burlington, N.J.	Steel plate	534	20	10,700	15,500	2,530,000
Tees River, England	Concrete	274	38	10,500	17,500	5,400,000
Hackensack River, (Newark Turnpike)	Concrete	200	40	8,000	12,500	2,460,000

The lift spans have much larger deck areas than any previously designed. Length and weight do not in themselves determine the importance of a span. Great weight may be due to the uneconomic use of a concrete floor slab. Length becomes more important with a substantial width. One of the controlling design features is the unbalanced load which may have to be cared for

ARTIST'S SKETCH OF HARLEM RIVER CROSSING

due to wind and snow or ice on the movable span, and this is a direct function of the deck area.

REDUCING THE WEIGHTS OF THE LIFT SPANS

Span weights were greatly reduced through the use of a welded steel-plate floor with thin asphaltic surfacing, the use of silicon steel, and the elimination of machinery and housing from the lift span. In Table I it will be seen that the Bronx lift span is the heaviest so far designed, while both it and the Harlem lift span have deck areas larger than any previously constructed.

As the Harlem and Bronx bridges are located within sight of each other, it was deemed essential that the two structures should be similar in appearance. The method to be used for the operation of the lift span required early decision, the choice being between the conventional design with operating machinery and operator at the center of the span, and the less customary one with operating machinery and operator on the towers. The newer arrangement, with the machinery on the towers, was adopted as the most satisfactory, bearing in mind the particular conditions to be met. The appearance of the bridge was improved by removing from the lift span the usual machinery house, operator's house, and operating cables. Also this plan reduced the weight of the lift span approximately 12 per cent—a very important factor.

Operation from the towers having been decided upon, the development of the type of tower to be used followed naturally. The great distance between trusses, together with the existence of rock foundations at reasonable depths, permitted economy in the use of two separate units for each pier as an alternative to a single extremely long pier. The space requirements for housing the switchboard, transformers, and auxiliary power units suggested the use of large hollow piers. These, in turn, were well adapted economically, structurally, and architecturally to the support of the eight-column towers which carry on their tops the housings for the operating equipment. It was possible to hang the main counterweights wholly within the transverse bracing near the tops of the towers, and to place the operator's and gate tender's houses, auxiliary counterweights, and elevators within the tower legs.

The Harlem bridge, shown in Fig. 1, includes a 153-ft approach span on the Manhattan side, a 310-ft vertical-lift span over the channel, and a 242-ft approach span on the Randall's Island side, all supported on concrete piers founded on rock. Six traffic lanes are provided between the trusses, which are spaced 75 ft 6 in. on centers, and two 7-ft sidewalks extend outside.

Three truss spans also make up the Bronx bridge—a central span of 350 ft and two flanking spans of 91 ft each, all supported on concrete piers founded on rock. This bridge provides for eight lanes of traffic. Two 7-ft sidewalks are provided on cantilever brackets outside the trusses, which are spaced 95 ft 6 in. on centers. As similar details were used for both bridges, and as only the Harlem span is now operable as a lift span, the remainder of the article will be confined to that structure.

DETERMINING THE BEST TYPE OF LIGHT-WEIGHT FLOOR

Because of the large deck area, the selection of a suitable floor was most important. A detailed study was made of a number of floor types, including silicon and carbon steel plates, interlocking channels, concrete-filled gratings, open gratings, and reinforced concrete. Comparable designs were made for each type, and costs determined, allowance being made for differences in the trusses, towers, and operating equipment resulting from variations in floor weights.

These cost estimates established the economy of a light-weight floor, the reinforced-concrete floor showing up unfavorably because its greater weight increased the cost of the operating equipment. There was little choice between the various light-weight floors from the standpoint of cost. A silicon-steel plate floor with thin asphalt-plank wearing surface was finally selected, as it showed up favorably in the cost comparisons; had the advantage of light weight (only the open grating being lighter); permitted the use of a standard asphaltic wearing surface; avoided the use of a patented article, thus giving free competition; was simple and substantial in construction, without the use of thin metal sections; and promised low maintenance costs.

A cross-section of the lift-span floor is shown in Fig. 2. The floor is divided into two 3-lane roadways, separated by a center island on which are placed the lighting standards. The outer 18 in. of each roadway is given a slope of 1 on 3 to warn the driver of a vehicle that he is nearing the barrier.

The wearing surface, of 1-in. mineral-surfaced asphalt

plank, is divided into units about 10 ft wide and 20 ft long by vertical retaining strips welded to the floor plates, which in turn are welded by flange intermittent-fillet welds to substringers. These rest on cross-beams, which in turn are supported on I-beam stringers. This multiple system of beams was used to reduce to a minimum local dishing of the floor under heavy wheel loads, the maximum relative deflection between adjacent substringers under an 18,000-lb wheel load with 75 per cent impact being estimated at a trifle less than $^1/_{16}$ in. The substringer section was taken as a T-beam, using 14 in. of plate as flange area. This T-beam section then has a bending strength one-third more than the I-beam alone, and top-fiber stresses only 31 per cent of the maximum at the bottom fiber.

The substringers and floor plates were shop-welded together into units about 39 ft long, there being five such units in the width of each roadway. Each plate was placed in a frame before welding, and bent into an arc transversely, and into a lesser but opposite arc longitudinally. When the plate was released from the frame upon cooling of the welds, it was found to have a uniformly level surface with little variation. (The amount of bend to be employed to secure a final plane surface was determined by experimentation.) The entire floor system was then assembled in the shop in correct relative position for reaming field connections.

In the field, the welding-together of the floor units and the riveting of the substringers to the cross-beams were carried out in a prescribed sequence to minimize transverse bending of the substringers and plates due to shrinkage of the longitudinal welds in cooling. After aligning the stringer units, to match holes between substringers and cross-beams, the two outside units were moved out $^1/_8$ in. (the measured shrinkage of one weld) and securely bolted to the cross-beams. The three middle units were then riveted to the cross-beams, the two outer welds completed, and the two inner welds made. Next the bolts were loosened on the two outer sections, permitting them to move in $^1/_8$ in. They were then riveted to the cross-beams. Welding of the transverse joints followed. At the request of the contractor for the Bronx span, the substringers were attached to the cross-beams with intermittent welds. In this way the necessity for matching rivet holes was avoided, and the elimination of large locked-up stresses was simplified.

Stringers and all floorbeams except the end ones are of silicon steel. End floorbeams were made of carbon steel to reduce their deflections with respect to the adjacent floorbeam on the tower span as a heavy wheel load passes over the floor joint. All floorbeams were cambered for dead load and their ends were beveled about $^1/_8$ in. so that the posts and hangers would be truly vertical under full dead load.

The trusses are of the Warren type with verticals, and are of silicon steel except for vertical posts and the four middle diagonals. Bottom laterals are of silicon steel to allow for chord participation stresses. Carbon-steel sway frames are provided between trusses at even-numbered panel points. Deep lifting girders at each end of the span serve as portals. The carbon-steel top-lateral system is arranged as a double triangular truss, with diagonal members extending over two truss panels and connecting to the chords at odd-numbered panel points. This system is completed in each end panel by two diagonals intersecting the lifting girders on the center line of the bridge, and by a longitudinal strut and bracing frame from the middle of the lifting girder to the first sway frame. The lifting girders are deep double-plane girders with solid webs near their ends and heavy angle trussing elsewhere.

Combined guide and centering castings, riveted to the bottom chord at each end of the lift-span truss, engage projecting guides on the tower columns, thus holding the span in position longitudinally and transversely. The shoes at all four corners of the span consist of cast-steel rockers bearing on cast-steel pedestals. On the approach spans, provision was made in the shoes for transverse and longitudinal temperature movements.

AN INGENIOUS SYSTEM OF AUXILIARY COUNTERWEIGHTS

The main counterweight ropes, 96 in number, are plow-steel wire ropes $2^1/_4$ in. in diameter, each consisting of 6 strands of 19 wires each with 6 filler wires, and having a minimum required ultimate strength of 404,000 lb. At each end of the lifting girder they are secured in four groups of six ropes each to short box girders located on the center lines of the lifting girders and connected to them by transverse diaphragms. The rope groups are arranged in two levels, one upper and one lower level being used for the 12 ropes leading to each tower sheave. The ropes are so spaced that each leads upward to its groove on the sheave in a vertical plane, and may be removed without interference with any other rope. Openings provided in the box girder webs opposite the sockets for the rope blocks give easy access for inspection and adjustment. At the tops of the towers the ropes pass over sheaves and are connected to concrete counterweights encased in steel boxes.

To overcome the unbalanced load of 62,000 lb resulting when the main counterweight ropes pass from the span side to the counterweight side as the span is raised

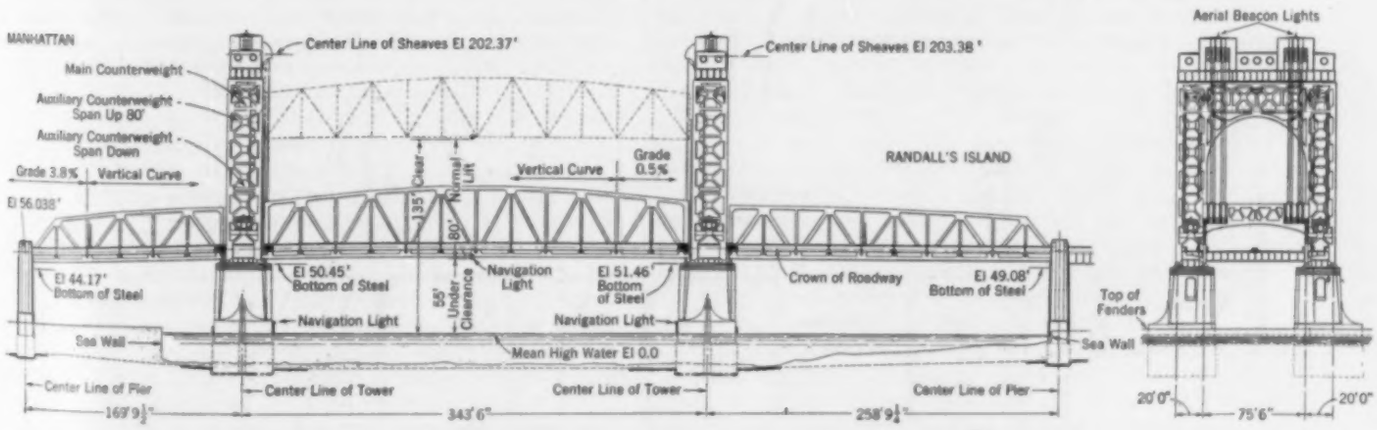


FIG. 1. SOUTH ELEVATION OF HARLEM BRIDGE AND CROSS-SECTION THROUGH LIFT SPAN

to full height, a system of auxiliary counterweights was devised instead of the usual cast-iron balance chains, which would have detracted from the appearance of the structure by hanging down within the tower arch. A small steel-encased concrete counterweight was hung inside each four-column tower leg, suspended on ropes which pass up and over two sheaves near the top of the towers and thence horizontally to connections with the main counterweight on the center line of the bridge. When the span is down, the auxiliary counterweights apply equal and opposite horizontal loads to each main counterweight. When the span is up, the auxiliary counterweights apply to the main counterweights inclined loads whose horizontal components are equal and opposite, and whose vertical components are upward.

The main counterweight sheaves have a pitch diameter of 15 ft and are of cast steel. Each sheave has a shrunk fit on a forged-steel shaft 23 in. in diameter. Journals are of 20-in. diameter, and are supported in bearings having bronze bushings.

These sheaves deliver the principal load on each tower, and as they are near the plane of the front columns, the dead-load stresses in the columns and the bracing are very unequal. To maintain the same general dimensions for the columns and principal bracing members and avoid waste, the more heavily stressed members were made of silicon steel, and the others of carbon steel. As the stresses in the tower columns and bracing members are statically indeterminate, it was necessary to approximate the sections before determining the true stresses by the method of virtual work ordinarily used in the solution of steel trussed arches. The internal redundancy of the structure, due to two diagonals in each panel, was considered directly in the analysis, so that the solution of the necessary equations gave the stresses in every member of the tower, based on the assumed sections.

AMPLE EMERGENCY OPERATING EQUIPMENT PROVIDED

Operation of the lift span is through electric motors and machinery placed at the tops of the towers. The operating machinery consists of a central herringbone-gear unit connected through a long transverse shaft to two herringbone-gear differential units located midway between the two counterweight sheaves at each side of the tower. Shafts from the differential units carry operating pinions, which engage racks bolted to the counterweight sheaves. The central unit is connected by means of gear trains and flexible couplings with the main operating motors and with an auxiliary motor. The transverse shaft is in several sections, connected together by flexible couplings. Those adjacent to the differential units are made adjustable by special drilling so that adjustment can be made if the lift span does not seat properly, that is, in case one shoe is high when the shoe of the opposite truss is seated. This adjustment can be made within an accuracy of plus or minus 0.011 in. of vertical movement. It is anticipated that such adjustment will be infrequent after final initial adjustment of the corners of the span to correct position.

Normally the lift span will be operated by four 200-hp motors which will raise the span to full height in approximately one minute. Except under large unbalanced loads, the span can be operated with three motors. Auxiliary operation is with two 60-hp motors with an operating time of about $7\frac{1}{2}$ minutes. Current for normal operation is 3-phase, 60-cycle, 120/208-v, alternating current, obtained from a power bank located a short distance from the Manhattan tower and stepped up to 440 v by means of transformers located in the Manhattan tower pier. Current for auxiliary operation is also ordinarily obtained from this power line, but may be obtained from a 425-hp gasoline generator set also located in the Manhattan tower pier.

Equalization or synchronization of travel of the ends of the lift span is provided normally by two synchronizing motors, one on each tower, of the same capacity as the main motors. By forcing the main motors on the two towers to travel at the same speed, these motors keep the ends of the span level within less than $\frac{1}{4}$ in. The synchronizing motor connection is maintained for about 5 sec after brakes are applied so that the ends may be kept level during braking, but is automatically broken 6 in. above the piers in order that the ends may be seated exactly. An auxiliary automatic synchronizing device can be used for emergency operation with the main motors; and a similar device will be used normally for keeping the span level when operating with auxiliary motors, or it can be kept level by a manual system when operating in the same manner. A skew limit switch automatically breaks the motor circuits and applies the brakes when the span gets more than 18 in. out of level.

Ten spring-set, electrically operated brakes control and stop the span, six on the main motor and synchronizing motor shafts and four on machinery shafts near the tower sheaves. Control of main and auxiliary motors is of the full magnetic type, with master switches which also control the brakes. A separate controller is provided for the machinery brakes, arranged to give variable torque for use in stopping the span or in retarding its movement as desired when coasting.

Limit switches cut power from the motors and apply the brakes near each end of span travel. Foot-operated push buttons permit operation beyond the cut-off points, but are made inactive, except at low speed, by a special speed governor. The same governor will cut power from the motors and apply the brakes if under extremely unbalanced conditions the span should overhaul the motors and travel at an excessive speed.

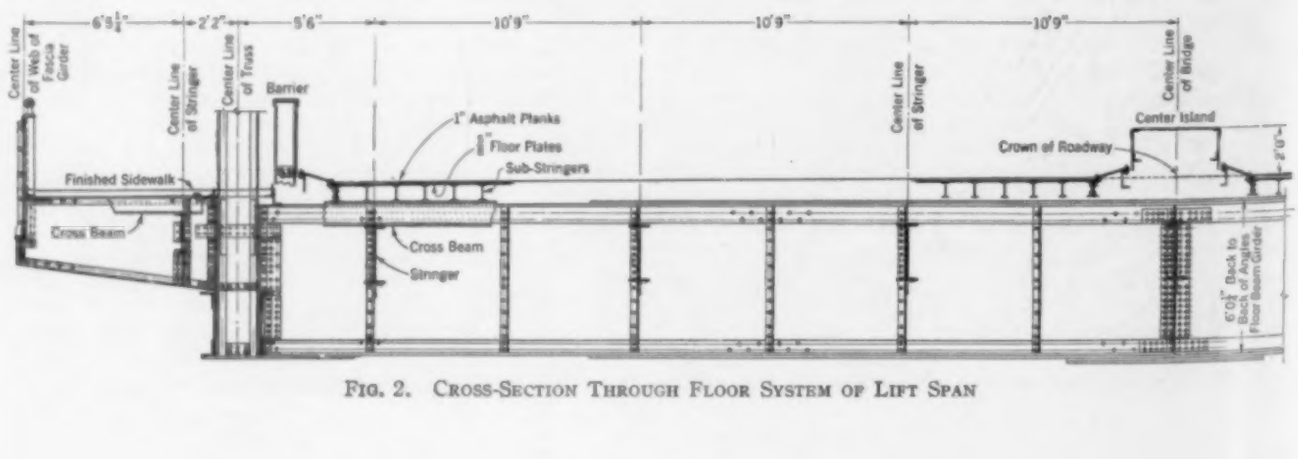


FIG. 2. CROSS-SECTION THROUGH FLOOR SYSTEM OF LIFT SPAN

ARTIST'S SKETCH OF BRONX KILLS CROSSING

The usual type of electrically operated traffic-signal gates, traffic-signal lights, and warning bells is provided. A manually operated barrier-gate is also provided between the signal gates and the lift span. All gates are interlocked with span operation in the usual manner.

Except for opening and closing the gates, all operations of the span are controlled from an operator's house located above the sidewalk level inside the north leg of the Manhattan tower. Similar houses are provided in the other three tower legs for the use of gate tenders, for storage, and for other purposes. A small elevator in each tower gives ready access to the machinery houses.

UNUSUAL ERECTION METHODS USED

The lift-span towers were each erected by a guy derrick supported on the approach span. This derrick was carried on beams resting on top of the trusses for erection of the lower part of the tower, and on a 65-ft steel tower for erection of the upper part. A stiff-leg derrick mounted on top of the tower was used to erect the counterweight sheaves and other equipment and to complete the ends of the lift span. The elimination of all derricks from the towers until they had been erected and riveted avoided rocking during erection operations, and without doubt was a factor in insuring the excellent alignment of the towers. Particular care was taken in the vertical and horizontal alignment of the counterweight sheave bearings so that the shafts for the two sheaves on each side of a tower would have the same axis, in order that the operating pinions might mesh properly with the racks on the sheaves. That the results were very satisfactory is evidenced by low resistances in operation. The latest test with auxiliary motors showed that the running motor torques to overcome machinery friction, rope bending, and counterweight sheave friction are about one-half the design values of the American Railway Engineering Association.

Navigation requirements on the Harlem River were such that the contractor had a choice of only two methods of procedure: Erecting the lift span in place in high position, or erecting it elsewhere and floating it into position. The contractor elected to use the latter method but departed from usual procedure to some extent.

The span was erected on two car floats each about 38 ft wide and 260 ft long, lashed together so as to give a distance of 43 ft center to center. While the floats were tied up to the dock at Weehawken, N.J., transverse A-frame supports about 11 ft high, centered on each float, were placed at each floorbeam location, and the entire floor system was erected on them, including bottom laterals and chords, and excepting only the two end panels. The remaining steel members of the lift span were piled up on the bridge deck as near their final position as practicable, and the floats towed to the site.

After the barges had been towed to the bridge site, additional steel carried on the barges was erected with a guy derrick supported on top of the Randall's Island approach span. The end panels were omitted but temporary end-truss diagonals were placed, which would clear the piers during the process of floating into place and permit connections to be made to the end lifting-girder frames. A floating derrick was also used for certain operations. In the meantime, the counterweight boxes were erected, suspended by steel hangers from the tops of the towers, and partially filled with concrete; counterweight ropes were placed; lifting-girder frames were erected and suspended from lines attached to erection brackets at the tops of the towers; and counterweight ropes were attached to the frames.

The lift span was floated in between the tower piers at a height about 40 ft below its normal position, and the lifting-girder frames were lowered to make connection with the lift span. The weight of the lift span was transferred from the floats to the counterweight ropes by the falling tide, aided by pumping water into the floats and by jacking down the counterweights with four 300-ton jacks on each tower. The lift span was raised by means of hoists to pier-top level; the permanent end bottom chords, end posts, and shoes placed; and the span brought to a seat on the piers. The lifting-girder end frames were then disconnected, the temporary end-truss diagonals removed, and the counterweights jacked up sufficiently to permit the lifting-girder end frames to be lowered into position for final connection to the span. After this the lift span was raised to high position. These operations consumed about 67 hours from the time the lift span was floated into the navigable channel, some time being lost on account of bad weather. The barges were ready to be floated out of the channel about seven hours after the channel was first blocked.

Trial operation of the span began about two weeks before the bridge was opened to traffic on July 11, 1936. Final adjustments in lift-span operation were made after that date. The general contractor for the Harlem River superstructure was the Taylor-Fichter Steel Construction Company. The Jones and Laughlin Steel Corporation fabricated the approach spans, and the Fort Pitt Bridge Works fabricated the towers and the lift span. All erection was handled by the general contractor. Electrical equipment was furnished by the General Electric Company. The Bronx Kills superstructure was fabricated and erected by the McClintic-Marshall Corporation as general contractor.

O. H. Ammann, M. Am. Soc. C.E., is chief engineer for the Triborough Bridge Authority. The superstructure plans and specifications for both the Harlem and the Bronx vertical-lift spans were prepared by Ash-Howard-Needles and Tammen.

The Engineer in Government Service

Distinguishing Between His Engineering and Civic Responsibilities

By E. M. MARKHAM

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
MAJOR GENERAL, CHIEF OF ENGINEERS, U. S. ARMY, WASHINGTON, D.C.

MORE engineers are in contact with and employed by the various federal bureaus today than at any previous time. One of the leading government agencies employing engineers is the Corps of Engineers, which has been called upon during the past three years to direct, in addition to its normal activities, a number of very large emergency relief work projects. With the work of the Corps as a background, General Markham points out that a project which may not be justified from a strictly engineering aspect may yet be of great value to the nation as a part of a country-wide emergency construction program. In developing this topic, he appeals for the broader view of public works, and looks forward to an increased influence for good government from engineers.

FOR more than a hundred years the Corps of Engineers has been one of the principal construction agencies of the government. Its work and responsibilities have been more than doubled during the past three years in connection with the emergency construction program, undertaken to provide relief employment and to stimulate the heavy construction industry. In this period its expenditures on construction have aggregated more than $580,000,000. These expanded duties the Corps has taken in its stride. The work involved had to be gotten under way rapidly, but without any sacrifice of engineering skill in either design or construction. Under these conditions successful results have been secured by a nation-wide organization composed of several thousand engineers, most of whom are members of the national societies. From surveyman to principal engineer, these men have given their best efforts faithfully and without stint, expecting no praise, but obtaining satisfaction from the work accomplished, for such is the engineer's creed.

RELIEF PROJECTS UNDER THE CORPS OF ENGINEERS

The expanded construction program has substantially advanced river and harbor improvement projects all over the country, including completion of the Atlantic Intracoastal Waterway to provide a protected route 1,435 miles in length from the Delaware River to Miami, Fla.; widening and deepening of the Cape Cod Canal to provide adequate facilities for the large boats plying between New York and Boston; a start on the work of deepening and widening the Chesapeake and Delaware Canal to provide a passage for ocean-going vessels between the Delaware River and Chesapeake Bay; the canalization program on the Upper Mississippi River, where the dams are of the roller type to prevent increased flood stages; regularization work on the Missouri River, which, in addition to providing a navigable channel, confines the river within its banks, preventing enormous annual damage from erosion; continued improvement of our seacoast harbors; and deepening of harbors and connecting channels in the Great Lakes. These improvements have given the nation an unequaled system of ports and inland waterways. These carry an annual commerce of more than 414,308,000 tons, valued at over $14,714,000,000.

Emergency funds have also contributed materially to the development of our water resources for purposes other than navigation. The largest hydraulic-fill dam ever constructed is well ahead of schedule at Fort Peck, Mont. This dam will impound 19,000,000 acre-ft of storage, which will be used to augment low-water flow on the Missouri River. It will also serve to reduce flood heights on the Upper Missouri River and to provide a source for large blocks of secondary power when a market is developed. On the Tygart River at Grafton, W.Va., construction of a gravity concrete dam 200 ft in height is well advanced. The reservoir formed by this dam will augment low-water flow on the Monongahela River to improve navigation conditions, and will also reduce flood heights in the Monongahela River basin. A combined navigation and hydro-electric development on the Columbia River at Bonneville, Ore., to be completed in 1937, will provide a lock for the accommodation of ocean-going vessels. The hydro-electric generating equipment which will eventually be installed at Bonneville will have a capacity of 430,000 kw.

A comprehensive flood control program is under construction in the Muskingum Valley, Ohio, embracing the construction of 14 reservoirs and related works. This project is being undertaken by the Corps of Engineers under a cooperative arrangement with the Muskingum Valley Conservancy District, under which the District furnishes all lands and rights of way, assumes responsibility for any damages during construction, and agrees to

THE SAGAMORE BRIDGE OVER THE CAPE COD CANAL. CONSTRUCTED BY THE NORTH ATLANTIC DIVISION, CORPS OF ENGINEERS

operate and maintain the completed structures. It is interesting to note that conditions very similar to the terms of this agreement were incorporated in general flood-control legislation recently adopted by Congress.

Other interesting flood control projects include the construction of three reservoirs on the Winooski River in Vermont, and a channel rectification program on the Wallkill River in New York, both undertaken with Civilian Conservation Corps personnel; the Conchas Dam on the South Canadian River in New Mexico; and the Sardis Dam in the Yazoo River basin, Mississippi. As a part of the Works Progress Administration program, the Corps is also engaged in a comprehensive program in Los Angeles County, designed to reduce the severe damages occasioned by the rapid runoff from the foothill regions, and in a reservoir program for the Brazos River basin in Texas.

OUTLET WORKS OF THE WILLS CREEK DAM, LOOKING SOUTH, OHIO RIVER DIVISION

While these extensive operations have been a real factor in increasing employment and in restoring more favorable conditions in the heavy construction industry, they are at the same time providing permanent and worth-while improvements. They have also served to bring the engineer into closer relationship with the government. More engineers are now employed by the government than at any other time in its history; and still more, as representatives of public and private agencies, are coming into frequent and intimate contact with government bureaus and agencies. As an engineer who has been in the government service for almost forty years, and as head of one of its major construction agencies, I am convinced that these contacts should be of real value both to the engineering profession at large and to the engineering organizations of the government, particularly as the profession becomes more familiar with the problems of the engineer in government service.

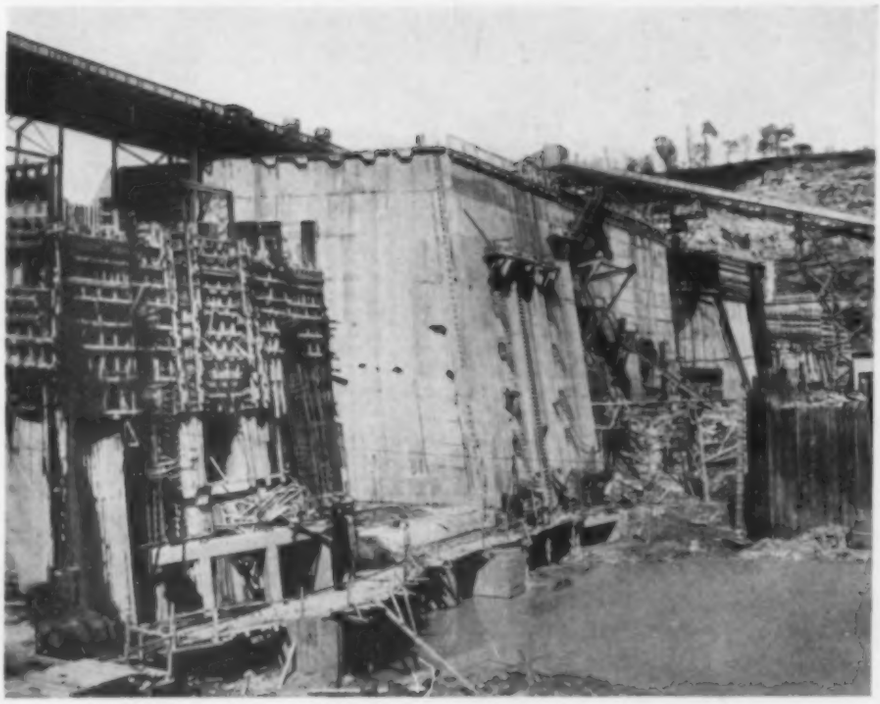
NEW SAVANNAH BLUFF LOCK AND DAM, ON THE SAVANNAH RIVER, SOUTH ATLANTIC DIVISION OFFICE

Any person who represents the government in an engineering capacity must remember that he is an engineer and not a statesman. The engineer is accustomed to think of his calling as an exact science based on mathematical analyses, although, realizing its inexactitudes, he uses a factor of safety in connection with his design. Does he allow our statesmen the same factor of safety? The engineer carefully plans our structures, using the predetermined factor of safety, and estimates the cost of construction with detailed precision. He then estimates the tangible benefits and establishes a relationship between their capitalized value and the cost of the project to determine its economic merit. If the annual benefits exceed the annual costs sufficiently for amortization, the project is considered justified.

Intangible benefits are likely to be dismissed by the engineer because they are incalculable and cannot be measured with accuracy. Nevertheless, it must be considered that during the life of a construction project, and with the continued advance this country is making, the intangible benefits may greatly exceed the tangible ones. There is no economic justification for the Washington Monument, but the inspiration it provides to the American people cannot be measured in dollars.

Normally, the first contact of an engineer with a construction project is to report on its feasibility and value. His duty is to find the facts and to make accurate estimates of construction costs and of anticipated benefits, so that they can be placed before the appropriate authorities for consideration. From these facts he makes his deductions and adds his unbiased conclusions and frank recommendations. If these are not accepted, the engineer must remember that his opinions and recommendations with respect to a specific project are necessarily limited in scope by the results of his engineering investigation, whereas the authority to whom the report is submitted may be considering the project in relation to a number of other projects or as part of a national policy. A project that may in itself lack justification from a strictly engineering viewpoint, may yet be of inestimable value to the country as part of a national program.

The engineer may disagree with this policy, and it is his privilege so to do as a citizen; but in such case the policy should be condemned rather than the individual projects or items contained in it, the largest of which can



POURING MONOLITHS ON THE RIGHT BANK OF THE TYGART RIVER DAM, GRAFTON, W.VA.

play but an insignificant part in the progress of the nation. The planning of the whole is no part of the engineer's duties. His task is to determine costs and values and to report on them without fear or favor. The plan of government, the advance of government structures, the entry of government into new fields—all these things are problems for the statesman and not for the engineer. There is no reason why an engineer could not make an excellent statesman. But in most cases he cannot be successful as both engineer and statesman at the same time.

THE GOVERNMENT WIDENS ITS CONSTRUCTION ACTIVITIES

In the past several years, the term "federal project" or "federal interest" has received much publicity, but its exact meaning is still not entirely clear to me in spite of many years in the government service. Early in its history, the government engaged in the improvement of transportation facilities under the constitutional authorization for the regulation of interstate commerce. Its construction activities have been extended throughout the years to include reclamation, flood control, mapping and geodesy, soil erosion, and other work contributing to the national welfare. The Emergency Relief Appropriation Act limited such activities only to "meritorious projects." There can be no doubt that any project which affects the well-being of any group of American citizens has federal interest. The extent of federal participation in such projects is dependent upon the national policy, upon the appropriations made available for the execution of such projects, and upon the ability and initiative of the benefited interests to participate in the resulting construction activities.

During the past several years, the relief of unemployment has been established by our statesmen as a national policy under which the government is authorized to enter into "meritorious projects" which accomplish this objective. Many engineers have protested against the limitation in cost per man-year for direct labor for the projects included in the present relief program. This may be due in large part to a misconception of that program, as it is difficult for an engineer to visualize an appropriation for work as other than a construction program. But, we may ask, was the relief program designed to provide primarily for major engineering projects or for the maximum employment to relieve labor, thereby avoiding a dole? If it was the latter, it could not be considered as a construction or engineering program.

A reading of the Emergency Relief Appropriation Act would indicate that our statesmen had clearly defined its main objective to be the relief of unemployment. The program, to be successful, had to accomplish that objective. There was a tendency on the part of the engineering profession to say that the objective could not be obtained, but what was really meant was that it could not be obtained without sacrificing many kinds of structures which engineers are proud to build. Many more projects would have been included in the relief program if their execution had been planned to provide for increased employment, even though at a slight increase in cost. Engineers have devoted years of sustained effort to reducing construction costs to a minimum, and it is difficult for them to discard their ambition to obtain the

DAM NO. 6, ON THE UPPER MISSISSIPPI RIVER NEAR TREMPEALEAU, WIS.

highest degree of construction efficiency. Our engineering viewpoint, however, may not be correct when considered in relation to the unemployment situation. Perhaps during periods of depression engineering work can be so regulated as to make increased employment a part of our goal. After such an objective has been established, engineers can certainly plan and execute the work to provide satisfactory structures, while utilizing the maximum man-service practicable without resort to primitive methods.

GENERAL VIEW OF CONTROL HOUSES AND COMPLETED DAM NO. 5, AT FOUNTAIN CITY, WIS. ON THE UPPER MISSISSIPPI

HUMAN RELATIONS IMPORTANT

The engineer has always been a good citizen. The nature of his work makes him both honest and analytical, without tolerance for waste and inefficiency. On a construction job, the successful engineer is one who has developed into a leader because of his understanding of the importance of human relations in the execution of any task. He exercises this knowledge in relationships with his employees, with the contractor, and with the public. However, he does not always carry this knowledge of human relations into his duties as a citizen. In the latter capacity he should not forget that human relations are sometimes more important than engineering conceptions, and that knowledge and faith may often justify work which could not be regarded as absolutely essential

CLOSING UPSTREAM ARM OF SECOND COFFERDAM, DAM NO. 26, AT ALTON, ILL.

from an engineering viewpoint. A town suffering from a built-up fear of possible destruction from tidal waves may make a mass demand for engineering protection, although the threat is remote. Public apprehension, public faith, and public desires must always be considered.

Like the engineer in private life, the engineer in government service forms a small part of a huge machine which depends for its satisfactory functioning on the development of team-work and coordinated effort within each and every bureau of the government, and between the government representatives and the public. The engineer, as a part of this team, must give his best efforts to the conception as a whole. The government engineer is, of course, a public servant who must be courteous and available to the public whom he serves. He must realize that the public has the right to receive correct and complete information with respect to the work under his jurisdiction. He must be reasonable in his relationship with contractors, as they too are entitled to fair and considerate treatment. He must avoid at all times any tendency to presume on the tremendous prestige and authority of the government which he represents; and he has the further problem of securing a uniformly high standard of public construction work. He must be adaptable and abreast of his profession.

In the work of the Corps of Engineers, we have been fortunate in securing the services of many outstanding engineers in a consulting capacity on our major projects. They have given us the value of their advice and experience for the specific problem in hand, and have brought the benefit of a fresh viewpoint to our own capable and efficient staff.

To be an engineer is to be a member of one of the highest professions open to man. To be successful in this profession, the engineer must have a sense of responsibility, a feeling of intense and honest loyalty to his employer, and intelligence and capacity of a high order. Great wealth and public acclaim will not be the reward of the engineer, but in lieu of these he will have the satisfaction of seeing the results of his efforts in permanent form, as a lasting monument even when others have forgotten his connection with the work.

The close feeling of personal responsibility for the construction project under his care is the one reward which the engineer can count on, but it makes his calling as an engineer real and worth while. Recently, I visited a field office in charge of the construction of a large dam. The district engineer referred to it as his dam; the resident engineer talked about it as his dam; the contractor and the contractor's engineer spoke of it as their dam; and I am rather certain that on my return to Washington, I was speaking of it as my dam.

The government engineer is, of course, but a small part of the team that runs the government. His responsibility is to his employers, the people of the United States, in the persons of their elected representatives, the executive and legislative branches of the government. As long as he recognizes his responsibility to the duly elected representatives of the people, he is satisfactorily performing his duties as an engineer. When he forgets this and comes to believe that his responsibility is directly to the people, he is thinking of himself as a statesman and will in all probability fail as an engineer. American engineers have the training, the capacity, and the talent to become its most constructive citizens, and these qualities properly exercised, can do much to secure good government to every political subdivision throughout the country.

Designs for Grouting at Boulder Dam

Presenting Principles and Leading Features of the Pressure-Grouting Work

By A. V. Werner

Assistant Engineer, U. S. Bureau of Reclamation, Denver, Colo.

IN developing a plan of construction that would provide a distribution of stresses in satisfactory agreement with design studies for the 726-ft high Boulder Dam, careful consideration had to be given to a number of matters which would have been of minor importance in smaller dams. As an example, pressure-grouting was employed to correct defects, reduce seepage, and eliminate uplift pressure in the foundations of dam, spillways, and intake towers; to control leakage in tunnels and tunnel structures; and to fill cracks and joints in the main dam, making it a monolithic structure despite its separate block construction. The use of unprecedentedly high pressures for grouting, together with a technique for decreasing the grout water-cement ratios with increased rate of pumping, is believed to have been largely responsible for the unusually successful results obtained. Mr. Werner's article, which discusses the principles involved and the more important features of the grouting activities as a whole, is the first of a series of five independent papers on the general subject of grouting work at Boulder Dam to appear in Civil Engineering. *The others, to be published in forthcoming issues, will deal with field methods for grouting tunnels, grouting of foundations, grouting contraction joints, and movement of dam blocks due to grouting, respectively.*

BOULDER Dam is practically completed. At the time of its inception no dam comparable in size and height had been attempted, and consequently there were no established precedents for much of the work. Figure 1 shows a plan of the dam and appurtenant works. Because of the height and tremendous pressures to be resisted, many details required careful consideration. One of these was pressure-grouting.

More than 417,000 cu ft of cement were used in grouting operations under pressures ranging from 50 to 1,000 lb per sq in. Some indication of the success of the work is afforded by the fact that early in 1936, after a year's storage of water having a maximum head of 400 ft, there was only about 1 cu ft per sec of measurable seepage appearing in the dam drainage galleries and in the tunnels downstream from the dam. Improved designs and methods of injection were developed which, it is believed, have added materially to the art of pressure-grouting.

Preparatory to actual design, exhaustive studies were made on the subject of pressure-grouting. Questionable phases of procedure were studied and conclusions verified by laboratory experiments. The geology of the site was carefully studied and plans for foundation and rock grouting were designed to correct as far as practicable defects in foundations and surrounding rock formations. Many tentative contraction-joint layouts were studied, particular attention being given to the design of grout stops and water seals, maximum size of joint areas that could be grouted in one operation, mixing and transporting equipment, flow of grout in pipes, relation of cement fineness to widths of cracks, safe maximum pressures, and other details. The efficacy of joint grouting was tested by core-drilling contraction joints of the Gibson and Deadwood dams, previously grouted, and by tests in connection with the grouting of joints in the Owyhee Dam. Full-sized models of parts of the proposed joints were tested to determine other doubtful matters of procedure. The effect of deflections in the columns or blocks forming the dam due to pressure of grout in joints was studied, and provisions were made for measuring crack openings and deflections by placing instruments between the blocks.

SOME GENERAL RULES FOR FOUNDATION GROUTING

Investigations at completed dams definitely prove that water-creep through the foundation and uplift pressure have not been entirely eliminated by pressure-grouting the foundations, partly owing to the fact that grouting was not completely effective. The plan and grouting procedure are primarily governed by local foundation conditions, but the wide variation in methods used appears to be partly due to lack of knowledge of the efficacy of various grout mixtures and the procedure best designed to secure thorough grout distribution, especially in sealing fine rock seams. As a result of studies at Boulder Dam, the following conclusions were reached regarding the technique and procedure of pressure grouting:

1. Extensive exploratory drilling of the foundation area should be done to reveal all features of the rock structure and to provide data for geological maps to be used as the basis for grouting and drainage plans. Hydraulic tests of drill holes will largely determine the plan and procedure necessary for effective grouting, and will also indicate safe limits for maximum pressures.

2. Proper arrangement of holes, number of lines, spacing and depth, are dependent upon the character of the rock formation. One line of holes, closely spaced, will provide a satisfactory cut-off for low dams or those of medium height on reasonably tight rock. A two-line, staggered-hole arrangement, however, gives a wider spread of grout, strengthens structurally weak rock over a greater area, and frees a greater portion of the foundation area from uplift pressure. Depth of hole is arbitrarily based upon the character of the rock formation, the length of the path of percolation, and other factors of dam design, and is generally from 25 to 30 per cent of the hydrostatic reservoir head above the foundation level at the hole. In general, the axis of a hole should be normal to the foundation surface.

3. In general, spacing of holes is arbitrarily based upon a consideration of the rock formation and the spacing considered necessary for a continuous grout curtain. Because the character of seams and fractures is variable and because the effective grouting radius is dependent upon the maximum pressure used, it is usually advisable to determine the spacing of holes experimentally. A minimum spacing may be outlined on the plans, and opportunity provided for economy by grouting widely spaced holes prior to drilling the intermediate holes. When core drills are used, cores may be examined for grout and holes tested for tightness.

4. Grout holes should be drilled with rotary-type

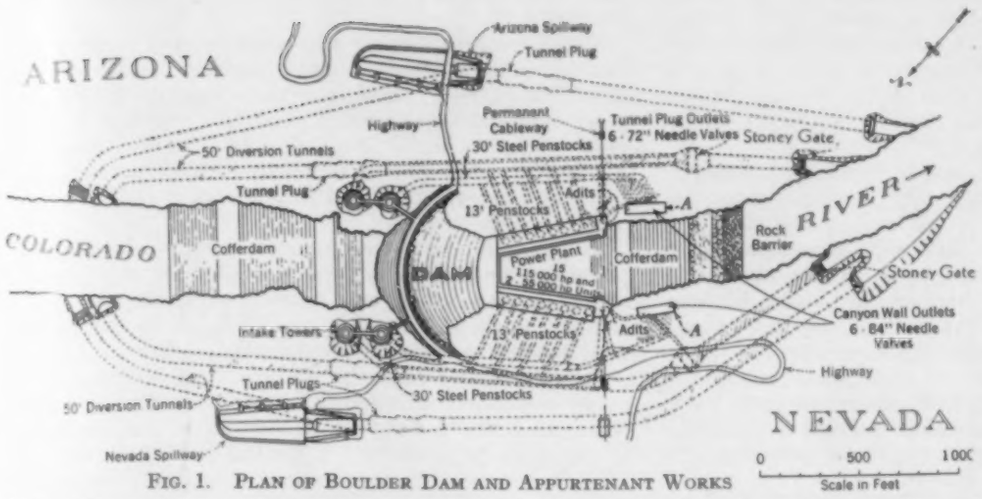


FIG. 1. PLAN OF BOULDER DAM AND APPURTENANT WORKS

drills. Percussion-type drills are unsuitable for seamy and broken rock, as dust and rock chips clog the seams and prevent the entrance of grout.

5. More effective distribution is secured by first drilling and grouting alternate holes of a one-line arrangement, or the downstream line of a two-line arrangement. Grouting of a hole should preferably be done after the concrete has been placed to a height of not less than 20 ft within a radius of 50 ft of the hole. Preferably, holes should not be drilled or left open closer than a distance of four hole spaces from a hole being grouted. Galleries eliminate interference with concrete work and permit better control of grouting.

6. In working with deep holes, the best results are secured by alternately drilling and grouting in depths of from 15 to 20 ft. By this method, the force of the injection is concentrated in a smaller depth and lateral distribution is more effective. Pressure is increased with each succeeding depth of hole so that the effective grouting radius is extended.

7. The best consistency for average work, where the addition of fine sand is not required, is obtained by the use of a water–portland cement ratio of about one. The consistency of thinner grout mixtures is determined by local conditions, a water-cement ratio of 10 being about the maximum dilution necessary. Some advantage may be obtained in grouting fine rock seams by the use of chemical solutions and silica compounds, or by admixtures of talc and diatomaceous earth, but the evidence is not conclusive.

8. It is difficult to adjust the consistency of cement grout to both wide and narrow seams. For maximum watertightness, ordinary grouting should be followed by redrilling and injection of thin grout under high pressure. Preliminary injections of chemicals or of colloidal substances may be advisable in some cases.

9. It is problematical whether a perfectly watertight grout curtain can be obtained and whether perfect work would entirely eliminate water seepage and uplift. Supplemental grouting may be required after the dam is tested under full head. If adequate drainage is provided, perfect grouting may not be necessary.

10. The deposition of fine silt on rock surfaces immediately above the dam will assist in sealing the foundation. Where clay is economically available, clay blankets placed upon upstream bedrock surfaces may also be advantageous.

11. Thorough washing of drill holes with water is necessary to remove drill dust and rock chips. Pressure injections of water into sealed holes may not completely wash out clay and rock fragments from deep seams and fissures, but are necessary for pressure tests, for measuring the grout required, and for wetting dry, porous rock. If the hole is water-tight no grouting is necessary.

12. Adequate equipment is important. Better results are obtained with the pump method of injection than with compressed-air grout tanks. Mechanical mixing, screening of grout mixtures, and pump supply tanks with mechanical agitators are necessary features.

13. Pressure-grouting with asphalt appears to be justified only when flowing water is encountered which cannot be effectively stopped with cement grout, as the life of asphalt under water pressure is questionable.

14. Successful execution of work depends largely upon the judgment of the engineer. Final analysis and future procedure are dependent upon a complete record, including evidence of effectiveness or deficiencies.

DAM IS FOUNDED ON ROCK OF GOOD QUALITY

Rock in the vicinity of the dam is probably all of tertiary or younger age, and is of excellent quality, although considerable faulting is evident. There are two major fault systems—main faults and slips.

The rocks on which the dam rests include two members of a varied volcanic series known as breccia, the older and lower being a sedimentary breccia. The term "breccia" signifies a rock composed of fragments which, in contrast with the rounded pebbles of a conglomerate, are of angular form. The fragments composing this lower breccia, ranging in size up to about one foot in diameter, are cemented together tightly enough to withstand compression tests of over 8,000 lb per sq in. These tests show that the rock is of more than ordinary strength. Water can pass through any considerable mass of the rock only by traveling through cracks or joints, and these are remarkably few.

This sedimentary breccia is overlain by a harder rock of more massive character, which is provisionally termed latite flow-breccia. Latite is a lava intermediate in composition between an andesite and a trachyte. The term "flow-breccia" signifies a lava crowded with small fragments of latite or andesite, incorporated when the rock was in a molten condition. The fragments are not cemented together but are held in a matrix of solidified lava. The latite flow-breccia is a very compact, homogeneous, solid rock.

The contact plane between the two types of rock is very inconspicuous, and in the vicinity of the dam site is from 100 to 200 ft above the river. The entire upper part of the dam abuts against the latite flow-breccia.

Faults are numerous in the general vicinity of the dam, but none of importance pass through the site. The faults strike generally northwest, or nearly at right angles to the course of the river. With few exceptions they dip south and have normal throws with a large horizontal or strike-slip component. The faulting occurred thousands of years ago, has entirely ceased, and most of the original fault fractures have been tightly sealed.

Seams are present to a reasonable depth, but are so

confined that excavation to remove them was not advisable. Excavation for the dam revealed tepid springs in the lower Nevada limits. A minor fault on the downstream branch of one fault (designated A-31) is tangent to the upstream face of the dam in the bottom of the gorge. The zone tightens in depth along a plane inclined steeply under the dam.

Since the foundation rock was of excellent character, broken only by fine seams and fractures, pressure-grouting was required mainly for sealing the rock and eliminating uplift pressure. Studies of stress conditions indicated that tension might develop in the foundation zone upstream, under the heel of the dam, because horizontal forces acting on the base of the dam would have a tendency to compress the concrete and rock. Such compression would tend to close seams under the toe and open up cracks at the heel, where the uplift force would be greatest. It was therefore decided to make the foundation as tight as possible by pressure-grouting, and to make elaborate provisions for drainage.

THREE TYPES OF PRESSURE-GROUTING EMPLOYED

Three distinct types of pressure-grouting were decided upon, designated for convenience as low-pressure grouting, high-pressure grouting, and contraction-joint grouting.

Low-pressure grouting, with pressures varying from 50 to 300 lb per sq in., was used to fill voids and to prepare rock areas for grouting at higher pressures, as it is generally applicable to conditions where voids are relatively large and surface leaks are probable. A thick mixture was used. Voids above concrete linings in tunnels and adits and in the concrete filling of plugs, of anchors, and around penstock pipes were filled with thick grout injected under low pressure. Holes for injection were provided by placing pipes in the concrete or by drilling shallow holes in the rock. The near-surface rock of the dam and spillway foundations was grouted under low pressure to seal up major fissures and crevices. Shallow holes generally 30 ft or less in depth were used for this work.

High-pressure grouting was used for rock zones under foundations and around tunnels under pressures varying from 250 to 1,000 lb per sq in. Grout was injected through deep diamond-drilled holes, and this method is more costly because of the deep drilling generally required. The terms "high-pressure grouting" and "low-pressure grouting" are relative and depend upon the particular project for their values.

Contraction-joint grouting is essentially a form of low-pressure grouting, which requires an elaborate system of piping with outlets and vents. Adequate grout stops are necessary and careful consideration of piping and vent systems must be followed in all designs.

It was realized that the details of the grouting technique would be controlled to a large extent by local conditions, and would have to be developed and improved as the work progressed. A general procedure was outlined, however, as it was realized that many of the field employees had very little previous experience in pressure-grouting. Ample latitude for the improvement of technique was provided for both the contractor's personnel and government inspectors.

PUMPS BELIEVED BEST FOR INJECTING GROUT

The specifications required that all grout should be pumped. Previous experience of the Bureau indicated that this was the most satisfactory method, because the cement mixture is forced directly and continuously into the places under treatment at a closely regulated pressure. Pressures up to 3,000 lb per sq in. can be developed if necessary, and the control is simple and flexible. The air-operated, duplex, piston-displacement, "slush" pumps were found to be the most satisfactory.

Except in low-pressure operations for filling large voids, very little sand was used. The undesirability of pumping sand is self-evident, as high velocities are re-

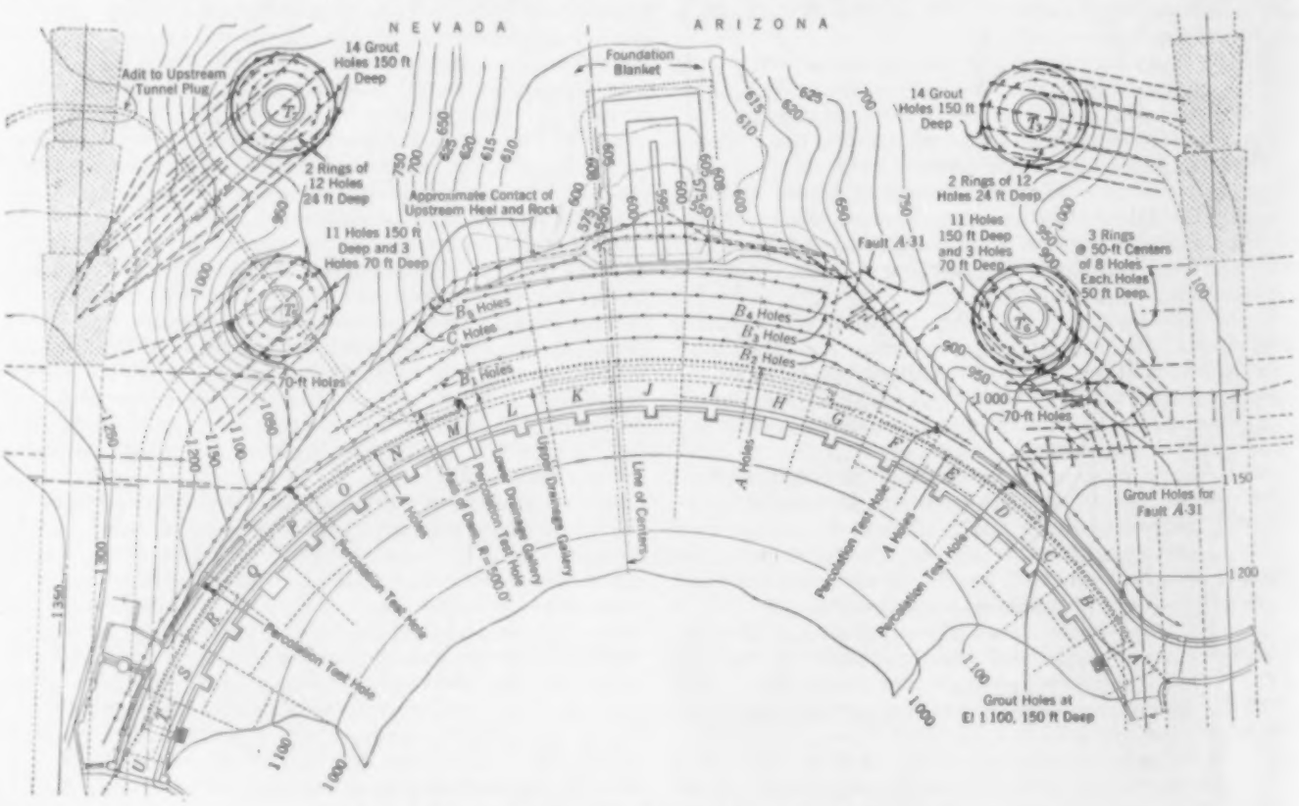

NEVADA
ARIZONA
Adit to Upstream Tunnel Plug
14 Grout Holes 150 ft Deep
2 Rings of 12 Holes 24 ft Deep
11 Holes 150 ft Deep and 3 Holes 70 ft Deep
70-ft Holes
Approximate Contact of Upstream Heel and Rock
Foundation Blanket
Fault A-31
14 Grout Holes 150 ft Deep
2 Rings of 12 Holes 24 ft Deep
11 Holes 150 ft Deep and 3 Holes 70 ft Deep
3 Rings @ 50-ft Centers of 8 Holes Each, Holes 50 ft Deep.
70-ft Holes
Grout Holes for Fault A-31
Grout Holes at El 1 100, 150 ft Deep
Percolation Test Hole
Lower Drainage Gallery
Upper Drainage Gallery
Axis of Dam, R = 600.0'
Line of Centers
A Holes
B Holes
C Holes

FIG. 2. PLAN FOR PRESSURE-GROUTING THE DAM FOUNDATION

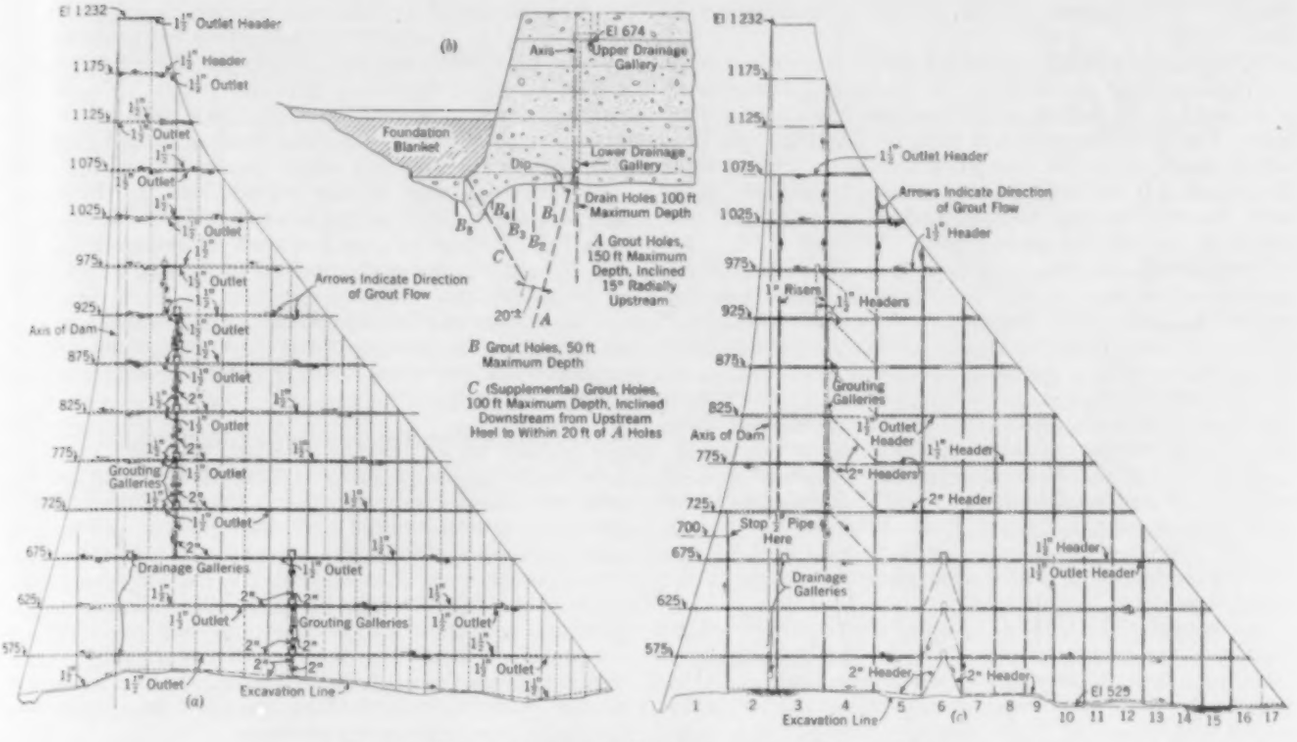


FIG. 3. RADIAL SECTIONAL ELEVATIONS OF BOULDER DAM

(*a*) Grouting System at a Radial Contraction Joint; (*b*) Arrangement of Grout Holes, Dam Foundation; (*c*) Grouting System at a Circumferential Contraction Joint

quired in pipe lines to maintain sand in suspension. Therefore, a mixture of cement and water was specified for most of the work. The consistency of the mixture, the use of fine cement (screened through 200-mesh sieves), and the pressure and rate of pumping, were dependent upon the character of the work and the procedure indicated in the first trials. Both laboratory and field experiments indicated that screened cement was advisable in grouting contraction joints and fine rock seams. A thin grout with a water-cement ratio of from 7 to 5 by volume was specified for the initial injection, with instructions to gradually thicken the mixture and increase the rate of pumping in accordance with the capacity and behavior of the hole.

Probably the most radical change from previous specifications was the requiring of extremely high pressures. As the frictional resistance to the flow of grout through minute seams and fissures is great, and as previous experience indicated that high pressures could safely be applied to relatively deep holes without lifting the foundation rock, it was assumed that by the use of higher pressures, greater penetration and more effective filling of seams would be secured and a greater grouting radius obtained for each hole. High-pressure grouting was generally preceded by low-pressure grouting of near-surface rock to seal up the major crevices and to prevent excessively high pressures from being transmitted to tunnel lining or structure-contact areas.

It is believed that the use of high pressures, together with a technic for decreasing water-cement ratios with increased rate of pumping, is largely responsible for the successful results obtained. It was found that the maximum pressure specified for grouting should be obtained by pumping at a constant pressure of 100 to 300 lb (as shown by the pump gage) in excess of the desired static or back pressure of the hole. It is important to pump at a constant pressure continuously to force the maximum amount of grout into the hole in the shortest possible time.

THREE SYSTEMS OF GROUT HOLES FOR DAM FOUNDATION

The plan for pressure-grouting the dam foundation, shown in Fig. 2, provided for low-pressure grouting the near-surface rock under the upstream part of the dam from shallow holes designated as "B" holes. The main grout curtain, located parallel to and a short distance below the axis of the dam, was to be provided by high-pressure grouting of deep holes along the "A" line, which followed the upstream edge of the drainage galleries. A supplemental or secondary grout curtain, extending to El. 775, was located under the upstream heel of the dam along the "C" line, as shown in the sectional elevation, Fig. 3 (*b*). The main grout curtain was to be extended into the abutment rock by high-pressure grouting of deep holes drilled from the diversion and penstock tunnels and of holes drilled along approximately the same line from the surface, with a view toward ultimately extending the grout curtain completely across the canyon. The foundations under and around the intake towers were also grouted through deep holes drilled both from the tunnels and from the surface.

The low-pressure "B" holes were grouted before concrete was placed to seal the near-surface rock strata so as to prevent the leakage of high-pressure grout from the "A" and "C" holes and to insure greater penetration and sealing of fine rock seams by the high-pressure grouting. Thorough grouting under the upstream part of the dam was also designed to reduce uplift pressure in this zone as much as possible. The "B" holes were from 30 to 50 ft deep, spaced about 20 ft apart, and staggered, with additional holes where necessary for local defects and faults. Grout pressures varying from 150 to 300 lb per sq in. were specified, with instructions that pressures should be as high as local conditions would safely

permit. A maximum of 400 lb was actually used in many holes.

To prevent grouting operations from interfering with the rapid placing of concrete, the drainage galleries were so located as to permit grouting from them of the "A" line. The galleries were 5 ft wide by 7 ft high and provided ample space for the work. The "A" holes were drilled on 5-ft centers approximately. Alternate holes were grouted in the first operation, and drilling and grouting of intermediate holes followed. All "A" holes below El. 675 were 150 ft deep. Above this elevation the depth was gradually decreased to 100 ft at the top of the dam. "A" holes were drilled at an angle of 15 deg upstream from the vertical and fanned out radially to facilitate drilling, to keep the grout zone under the heel of the dam, and to permit vertical drain holes from the same galleries to be located as far downstream from the grouted zone as possible.

All holes had a minimum diameter, at the bottom, of one inch, which was thought to be the most economical and suitable size for deep grout holes in good rock. Larger holes would increase drilling costs and have a greater tendency to clog during grouting owing to the lower velocity of the mixture.

It was required that no "A" hole be grouted before 100 ft of concrete had been placed above the hole, the concrete cooled, and the contraction joints grouted. This was designed to guard against any filling of contraction joints with grout at high pressure from the "A" line, and to provide sufficient weight above the hole to avoid displacement of the rock. The specified grouting pressures were:

Below El. 800	1,000 lb per sq in.
El. 800 to El. 1,000	750 lb per sq in.
Above El. 1,000	500 lb per sq in.

All holes were to be started with finely ground cement, 98 per cent of which would pass a 200-mesh screen. If a hole took more than 300 sacks of screened cement and the stalling pressure was less than 500 lb, however, the cheaper unscreened cement could be used until the hole refused cement at 500-lb pressure, at which time rescreened cement should again be injected.

The "C" holes were drilled through pipes placed in the fillet at the heel of the dam. It was originally intended to grout the "A" line first, but storage was begun before the "A" line was completed and the plan had to be reversed. Excavation disclosed that fault A-31 dipped downstream under the heel of the dam. Although the fault was tight, it was considered advisable to grout it.

PREPARATIONS FOR GROUTING CONTRACTION JOINTS

The dam is divided, by radial and circumferential contraction joints, into blocks varying in size from 25 by 30 ft at the downstream face to 50 by 50 ft at the upstream face. The radial and circumferential joints are interlocked by means of keys formed to provide maximum resistance to shear after grouting. Metal grout stops are placed across radial joints at both faces of the dam and across the circumferential joints at each junction with a radial joint. Vertically the stops are placed at 50-ft intervals.

The necessity for producing a crack of sufficient width for grouting purposes without causing so much shrinkage in the mass as to produce cracks at other than contraction joints, was responsible for the block layout.

In Figs. 3 (*a*) and 3 (*c*) is shown the design of the contraction-joint grouting system, based on experience gained by the Bureau in the construction of the Gibson and Owyhee dams. It consists of lower and upper headers connected at intervals by risers equipped with outlet boxes or condulets for admitting the grout to the joints. The grout was forced into the lower header and thence through the risers into the joints. The upper header served as a vent to allow the escape of air and water from the joint. Injection was continued until the grout returning from the upper header was of the same consistency as that in the supply header. Pressures were limited to 50 lb per sq in., and adjacent joints were kept full of water to guard against displacement of the columns and to prevent infection of an ungrouted joint by grout leakage.

The abutment contact planes were provided with a similar grouting system through which grout will be applied when the reservoir is full and the dam has been given its full deflection.

GROUTING THE SPILLWAY FOUNDATIONS

In designing the grouting system for the spillways, the principal object was to consolidate the foundations and to provide a cut-off against percolating water. The spillway weirs are really gravity-type dams 75 ft high on the Nevada side and 85 ft high on the Arizona side. Because of the depths of the channels below the weirs, considerable attention was paid to grouting and drainage provisions to insure the safety of the weirs, and prevent water pressure on the channel linings. The same system of grouting employed on the dam foundation was applied to the spillway foundations.

The surface rock under the weirs and channels was first sealed by grouting shallow holes under limited pressure. A cut-off curtain was created by the high-pressure grouting of holes 100 ft deep, spaced 10 ft apart along the upstream edges of the spillway weirs. Considerable porous rock was revealed, and screened cement under high pressure was injected in these areas. Because of porous rock in the Arizona spillway area and some badly fractured rock on the Nevada side, the rock slopes below the upstream side of the Nevada spillway were covered with gunite, and the forebay area above the Arizona spillway was blanketed with clay soil.

A summary of the amount of grout used is given in Table I.

TABLE I. SUMMARY OF GROUTING WORK

FEATURE	DRILLING Lin Ft	GROUTING Cu Ft
Spillway foundations	36,018	21,931
Intake tower foundations	10,964	8,228
Dam foundations	68,462	74,590
Under dam abutments from tunnels	27,128	24,458
Diversion and penstock tunnels	150,582	224,751
Tunnel anchors and manifolds	1,442	9,848
Adits and miscellaneous	9,332	12,495
Dam contraction joints	...	33,477
Tunnel plug contraction joints	...	7,271
Total	303,928	417,049

Foundation grouting studies and designs were prepared under the direction of Senior Engineer W. E. Blomgren, to whom I am indebted for many helpful criticisms and suggestions. The designs for the contraction joints and joint grouting systems were prepared under the direction of Senior Engineer J. J. Hammond, Assoc. M. Am. Soc. C.E., and all Boulder Dam designs were prepared under the supervision of B. W. Steele, Assoc. M. Am. Soc. C.E., designing engineer on dams. All Bureau of Reclamation work is directed by the Commissioner (the late Elwood Mead, M. Am. Soc. C.E., John C. Page, acting) in Washington, D. C. The chief engineer is R. F. Walter, and the chief designing engineer is J. L. Savage, both Members Am. Soc. C.E.

The Scientific Approach to Traffic Problems

Adequate Control of Traffic in Our Large Cities Requires Engineering Technique

By LEWIS W. McINTYRE

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ALMOST everyone drives an automobile. Almost everyone is therefore well aware that the traffic control problem is not being given the attention that its seriousness warrants. Delays caused by unnecessary traffic signals at some intersections are surpassed only by the confusion and altercations occurring at other points where the necessary control is missing. Such conditions, which prevail here and there in every large city, illustrate only one of the many traffic problems that need the scientific approach of the engineer for satisfactory solution. In this article, which is abstracted from a paper delivered before the annual meeting of the Society for the Promotion of Engineering Education held at Atlanta, Ga., on June 24, 1935, Mr. McIntyre demonstrates that there is such a thing as a scientific approach to the traffic problem, offers arguments to show its importance, and urges an active interest in securing adequate control.

PRACTICALLY every city and town in this country is concerned with the problem of adapting its eighteenth or nineteenth century street system to twentieth century traffic conditions. This involves not only remodeling old street patterns and widths but also securing the maximum efficiency for existing thoroughfares. It involves scientific planning of new arteries where such are possible; a solution of the parking or terminal problem; a scientific study of traffic accidents to eliminate their causes; the better education of motorists; development of scientific methods of law enforcement; and new types of organizations to bring about coordination of the construction, engineering, educational, and enforcement activities.

Traffic engineering has had a rapid growth during the past ten years, and it is now a definitely established branch of engineering. It is probable that this growth will continue, but it should be recognized that the demand for traffic engineers will never reach a volume comparable to that in the standard branches of engineering. The field is an engineering specialty, and it is not desirable to tempt a larger number of men into it than can be profitably employed. Permanency of employment in traffic engineering work is more subject to the vagaries of politics than other forms of public employment, except possibly the consulting field, and in this it corresponds to highway engineering 25 years ago.

Almost everyone drives an automobile. Therefore, it seems, almost everyone thinks he knows how traffic should be handled. Even many engineers do not appreciate the fact that scientific principles can be applied to the control of traffic movement. By tradition furthermore, traffic has been under the control of the police departments. While many phases of traffic control still are and should be controlled by police departments, it requires patience, diplomacy, and engineering skill of a high order to achieve results under such conditions. Nevertheless results have been achieved and much progress has been made.

Many persons who have no direct control over traffic engineering work can influence traffic control policies and help to prevent the blunders which are frequently made. In some cases engineers who have had a course in traffic engineering have served as chairmen of traffic committees, chambers of commerce, automobile clubs, and local engineering societies. As it will probably be many years before all cities have traffic engineers, municipalities which do not have them must depend upon other persons for any effective traffic engineering work that is done.

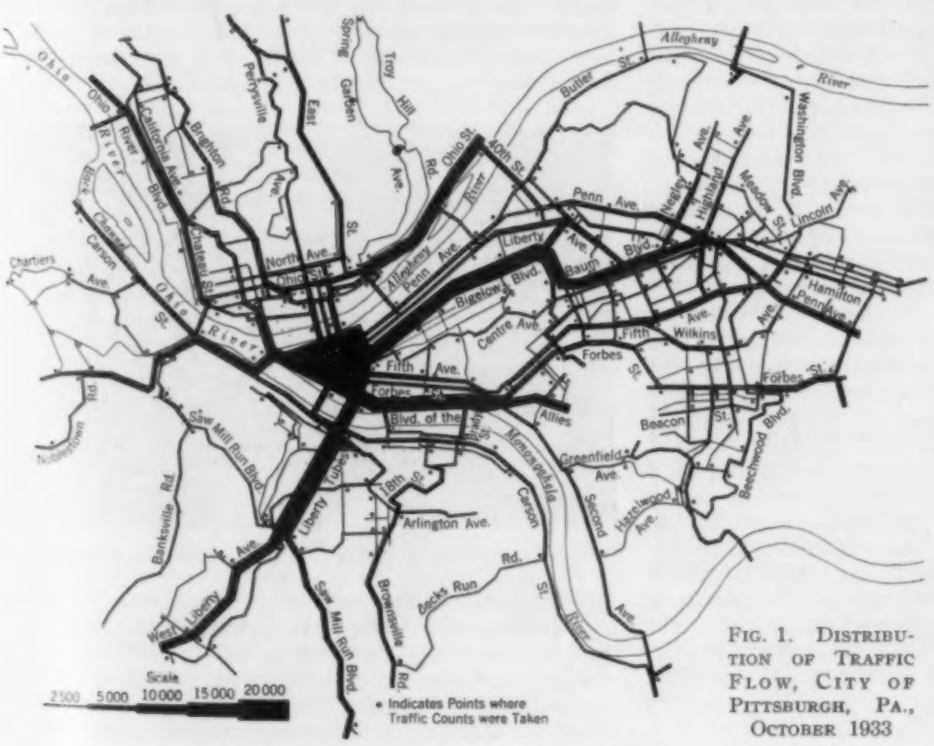


FIG. 1. DISTRIBUTION OF TRAFFIC FLOW, CITY OF PITTSBURGH, PA., OCTOBER 1933

DEVELOPMENT OF THE MODERN TRAFFIC SIGNAL

Prior to 1900, police gave attention to traffic only when there were parades, or disputes between drivers. Officers were probably first assigned to traffic duty in 1903 in New York City. The first experiment to interrelate the movement of traffic at various intersections was made in 1913 in New York City, consisting of the use of signal flags and hand-operated semaphores. The first installation of traffic signals was in Cleveland in 1914. In Salt Lake City in 1917 the signal

lights were first staggered, giving a progressive system. The first traffic tower was put into operation on Fifth Avenue in New York City in 1920. These towers were not connected for simultaneous operation. When the officer in charge of the master tower changed his signal, those in charge of the adjacent towers did likewise.

The first installation of an electrically interconnected

THIS SERIOUS TRAFFIC SITUATION WAS GREATLY IMPROVED BY REDUCING THE SIZE OF THE TRAFFIC CIRCLE, INSTALLING SPECIAL SIGNALS, AND PROPERLY PAINTING ROADWAY LINES

signal that could be controlled automatically was made in Houston, Tex., early in 1922. The first modern four-way signal with the general appearance of the present-day signal was installed at State and James streets in Syracuse, N.Y., in 1922, and less than a year later the famous Michigan Avenue signal system was installed in Chicago. In February 1926, the noteworthy flexible progressive system of 49 signals operated from a central control board was introduced in Chicago. In April 1928 the first installation of traffic-actuated signals was made at Orange and Humphreys streets in New Haven, Conn.

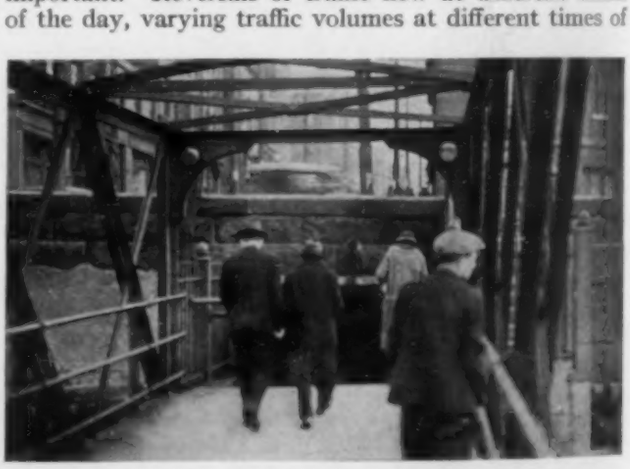
The rectangular plan of street layout is of extreme antiquity. Many medieval cities were constructed with circumferential walls and fortcifiations for defense purposes. The space occupied by these walls, after the walls themselves had been demolished, was used for circumferential streets and boulevards. Although several cities early used radial thoroughfares superimposed on the rectangular system, the significant developments in street and highway planning are of comparatively recent origin. These include the use of traffic loops for by-passing through traffic around, but sufficiently close to business districts, and during the past ten years super-highways have come into prominence for handling dense traffic. The New Jersey approach to the George Washington Bridge, the West Side elevated highway in New York, and Wacker Drive in Chicago are notable examples. Many of these highways have complete grade separations of the clover-leaf or similar type. A city plan that has been much discussed recently is that of Radburn, N.J. This uses a principle of carrying through traffic on a limited number of main streets with intersections at widely separated intervals. Residential streets do not run through, thus discouraging through traffic.

The first teaching of the elements of traffic control in any college course was probably at the University of Michigan in 1921, followed by some instruction at the University of Pittsburgh in 1923. The first full-time traffic engineer was employed in Pittsburgh in 1925. The Institute of Traffic Engineers, the professional society for traffic engineers, was formed in 1930.

Let us examine a few of the phases of city traffic problems. Probably the most spectacular is that of traffic signals. To install a stop-and-go signal at an intersection seems a rather simple matter. It is evident, of course, that there are problems in electrical design involved in the building of such a piece of apparatus, but first it must be determined where such control apparatus is justified and where it will function. This involves a careful study of traffic volume (Fig. 1), types of movement, variations of movement during different periods of the day, types of accidents occurring at the intersection, proper proportion of signal period on the various streets, proper total signal cycle so as to avoid undue delay to traffic, and determination of those hours of the day during which the signal should operate.

I wish to emphasize particularly that a traffic signal is by no means a cure-all for accidents. Improperly installed it is quite likely to cause accidents. Three independent studies covering about 600 intersections in widely scattered areas have shown that at 36 per cent of the intersections, at least, accidents were actually increased after the traffic signal was installed, and that at 30 per cent more, there was no change in the number of accidents. Surely these figures emphasize the need for scientific analysis before such signals are installed.

If sufficient fundamental data are available, the proper signal cycle can also be worked out by mathematical analysis. The work of Carl P. Nachod, member of the Institute of Traffic Engineers, is one of the many interesting developments along this line. The need for the scientific approach is even more obvious when we consider signal systems which are tied together, as in the case of the flexible progressive system which attempts to provide relatively continuous flow in every direction. The design of such a system involves an intimate factual knowledge of the time required to complete the various movements and turns. At all intersections a knowledge of the ratio of traffic volume in each of the various lanes of each street is needed. An analysis of the reservoir capacity available in various blocks where there are large infiltrations of traffic and the speed with which traffic can be made to move are important factors in determining the signal cycle. The length of blocks is important. Reversals of traffic flow at different times of the day, varying traffic volumes at different times of



PEDESTRIAN SUBWAYS HAVE A PLACE IN THE TRAFFIC SCHEME

the day, and variations in the interference of parking and loading with traffic movement must be considered. For instance, in the city of Pittsburgh, which still has the largest flexible progressive signal system in the world in its downtown district, the signal cycle is changed 13 times each day. A different type of coordination is

used during the morning and evening peaks, and a different flow speed on Sundays and holidays.

Let us consider the vehicle-operated traffic signal. Such a signal must have a so-called initial interval or green period of sufficient length to permit vehicles to start from rest and clear the intersection. This must be followed by a vehicle interval of somewhat shorter duration, just suitable for vehicles which are already moving to clear the intersection. But we cannot permit vehicles on one street to hold the right of way indefinitely. Therefore we must have a maximum time interval which will transfer the right of way to the opposing street at the proper time. Now what of the vehicle which approaches the intersection just as the maximum timer is transferring the right of way (end of the yellow period), but which does not have sufficient time to clear the intersection? Such a vehicle must stop, and the timer must have a memory feature which will transfer the right of way back at a later time to pass through. What of the vehicle which approaches the intersection just at the end of the green period, without having sufficient time to clear the intersection? Ordinarily the yellow period is adjusted to provide sufficient clearance period, but this marginal vehicle must have a little more time for clearance. There must accordingly be a time extension of the yellow interval. How far from the intersection shall the pads which actuate the timer be placed? This depends on normal vehicle speeds, grades of the street, and other factors. How shall we insert special periods for left turns? How shall the value of the results in dollars and cents be balanced against the cost of the equipment? Surely this brief summary is sufficient to indicate that the traffic-operated signal constitutes a problem for the engineer and not for the layman.

STANDARDIZATION OF TRAFFIC SIGNS NEEDED

In the matter of traffic signs, much has been done to bring about standardization, yet much remains to be done. What is the relative visibility of different colors, by both day and night? What size reflector buttons produce maximum visibility? Shall we use words or symbols? What are the relative values of the various shapes? How high shall signs be mounted to secure maximum effect? Under what circumstances is illumination justifiable? If we are to have practical and effective traffic control these matters must be determined by the engineer, using the scientific method of approach. Too many of our signs are erected by haphazard rule-of-thumb methods.

Let us examine, from the scientific point of view, such a comparatively simple matter as the elimination of a left-hand turn. How much extra mileage will be created by this elimination? How much extra congestion at other corners will result? How shall we mark the prohibition so that the result is not just more confusion? And will the elimination of the left turn merely produce a heavier turn either right or left at some other intersection? Will the turn be transferred to an intersection where the interference with pedestrians is greater than at the intersection from which the turn was eliminated? These are some of the questions which require answers before definite steps are taken.

Passing to the parking problem, we find that there are at least four classes of street use: (1) The safe and free movement of traffic; (2) the loading and unloading of vehicles; (3) short-time parking; and (4) long-time parking. Various classifications of regulations are in use. These have mostly been fixed haphazardly, and as a result no one is satisfied. The early-bird motorist arrives at a curb parking space and is permitted to park. He clings tenaciously to his privilege of parking on the street. Then there are other motorists who arrive too late to park, or who do not wish to park. They appreciate the ease with which they could move if there were no vehicles parked. Some merchants defend the rights of their more fortunate customers to park at the curb, while others defend the rights of less fortunate customers

THIS SIGNAL PERMITS A THREE-WAY TRAFFIC MOVEMENT THROUGH THE USE OF ARROW SIGNAL LENSES

who cannot conveniently drive to their stores and so choose to do business elsewhere. Then there is the truck driver who cannot find a place to unload his truck. All of the foregoing is complicated by haphazard enforcement methods and traffic-ticket fixing. Surely such a muddled state of affairs is not the result of applying the scientific method.

But what can be done? First a parking survey should be made to determine the parking demand characteristics. The availability of parking and storage lots and garages should also be determined. The available loading and unloading facilities, both street and off-street, must be surveyed. The street system should be studied, its roadway capacity determined, and its curb parking capacity found. The traffic flow characteristics of the street also have a bearing. What is the volume of flow? What kinds of vehicles use the street? What is the effect of parking on mass transportation? What is the speed of flow? What are the minimum headways when the street flows full? What is the accumulation of vehicle load in the district?

With such basic data as these, sound and proper regulations can be recommended. Such regulations simplify enforcement because it can easily be shown that they meet the actual needs. Merchants and other interested business people soon come to appreciate traffic work which is done along these lines and give it their hearty support. Motorists, too, realize that they are being treated fairly and are not being penalized because of the whim of some ill-informed official.

SCIENTIFIC METHODS AID IN REDUCING ACCIDENTS

The highway accident problem is an outstanding example of the application of the scientific method to traffic problems in cities. Motor vehicle and pedestrian accidents continue to mount, yet in spite of the increase in the national toll, certain cities where the scientific approach has been used have actually reduced their traffic accidents. For example, Pittsburgh in 1932 tied with Evanston, Ill., for first prize in the national traffic safety contest sponsored by the National Safety Council. It had shown a startling decrease in traffic accidents due to the use of the scientific method. In 1933 Pittsburgh

was second among cities of over 500,000 in this same contest. In 1934 it was again second, being beaten out by a few points by Milwaukee, whose enforcement efforts were outstanding.

How is the scientific approach applied in reducing traffic accidents? In the first place there must be developed a standard form of accident report so that the pertinent data with respect to each accident can be recorded. Next these reports are filed by location so that the worst accident locations can be studied first. Then each accident is charted on a large-scale plan of the location (Fig. 2). From these charts it will usually be found that accidents fall into certain classes. The basic cause of each class can often be found and the correction applied. The accident spot map is also useful in pointing out to officials and interested citizens why steps are being taken at certain locations and why corrective devices are being applied at one location despite the fact that there is an incessant clamor for action at other locations. By this means citizens can easily be shown the relative importance of the accident problem in various districts.

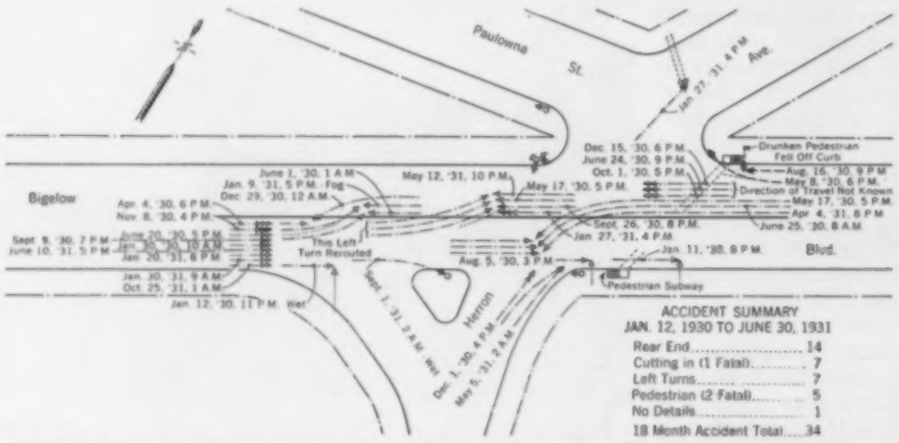


FIG. 2. COLLISION DIAGRAM OF A PITTSBURGH INTERSECTION WITH SIGNAL IN OPERATION AND DIRECT LEFT TURN

Construction of the Traffic Island and Rerouting Around It of Left Turns from West on Bigelow Boulevard, on July 1, 1931, Materially Reduced Accidents

Such accident studies are useful in enforcement work. Is it better to have "sharpshooting" enforcement or the "scatter-gun-barrage" type so often seen? Is it better to send an officer to a certain location looking for certain types of violation which are known to cause accidents, or is it better to send him out with the general instruction to merely enforce the law? When the latter policy is followed, the result too often is that motorists are harassed for offenses which actual statistics have shown to be of relatively minor importance as far as accidents are concerned.

The accident investigation squad is another result of applying scientific methods. This is a special police squad, equipped with a camera and a tape, organized to investigate accidents and to prosecute motorists who can be shown to have violated the motor code. When an accident occurs, the squad is notified by radio. It proceeds at once to the scene of the accident. Sketches are made of the location of the vehicles, photographs are taken, skid marks are located and photographed, and a complete case against the violator is developed. This is followed through to the courts and the offender is punished. Evanston, Ill., under the direction of Frank Kreml, has been particularly successful in the use of the accident investigation squad, which is largely responsible for the fact that Evanston tied with Pittsburgh for the first national safety prize in 1932.

Let us consider highway lighting. In these days of economy candle-power has been reduced and alternate lights turned off. A number of studies have shown a direct relation between highway lighting and highway accidents. Unfortunately the data are not sufficiently numerous, nor have they been given sufficient publicity. But even from the standpoint of economy, is it better to save a few dollars on highway lighting at the expense of losing many lives and many dollars in property damage accidents? I scarcely think so. The scientific approach develops the facts with respect to highway lighting and highway accidents, and presents such facts in understandable form.

STREET-CAR LOADING ZONES AND PEDESTRIAN TRAFFIC

There are so many phases of the traffic problem which illustrate the need for the scientific approach that to retell all of them would make this article of undue length. I might mention the question of street-car loading-zone design. What is the proper shape for the abutment? While recognizing the usefulness of the street-car loading zone as a means of by-passing traffic while street cars are loading, many persons discourage their use because of the number of accidents resulting from vehicles striking the abutment, particularly at night. Such abutments can be designed to minimize damage to vehicles striking them. A number of experiments have been conducted along this line, some with remarkable results.

The proper treatment of pedestrians is another most important phase of the traffic problem. Certainly the pedestrian has been grossly neglected. He has been given a certain right by law, but too many pedestrians have been killed defending their right of way. Some proper protection must be furnished. Shall it be separated pedestrian underpasses or overpasses? Shall it be a separate interval in the signal cycle during which only pedestrians may move? If this is adopted, it certainly means that pedestrians must submit to regulations just like motor vehicles. Or is a longer signal clearance period or a special signal clearance period designed for pedestrians practical? Pittsburgh has tried the latter method with considerable success, but many more data are needed on the results of these methods before we can properly measure their effectivenss. These are problems suited to the scientific approach.

Many other problems might be mentioned, among them the question of cruising taxicabs, the relation of mass transportation to our street systems, the proper methods of rounding curves and splaying out intersections, and problems of designing highways so as to make them more suitable for moving traffic. There are problems of street width; lane capacity; bridge approaches; arterial highway and parkway design; railroad crossing protection; proper organization and methods to be used by traffic police and school-boy patrols; proper traffic laws and regulations; proper control of the driver; and driver licensing. Then there is the whole field of traffic educational work. While the latter may not be strictly engineering, yet if it is to be effective, it must also be based on the scientific approach.

Selecting and Guiding Engineering Students

A System for Measuring Their Interests, Scholastic Ability, and Personality

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WHILE less urgent, perhaps, than many problems in later life, few decisions are more difficult for the average youth than the choice of a proper college course. Any yardstick which will indicate, however roughly, the aptitude of the prospective engineering student, is also of value to the teaching staff. No peculiar mental trait, at least of a measurable character, seems to exist which foreordains an individual to be an engineer or a member of some other profession. On the other hand, a system of tests administered to freshmen previous to regular registration at the Missouri School of Mines makes it possible for the faculty to predict with reasonable accuracy the degree of success which a given candidate may expect in engineering study. The following article, abstracted from Dr. Mann's address before the Student Chapter conference held at Hot Springs, Ark., on April 23, 1936, outlines graphically the development and application of the testing system.

THIRTY years ago our engineering magazines contained many heated arguments concerning the excellencies of "self-made" engineers versus those of college-trained men. However pertinent arguments of the kind may have been then, there seems now to be little question but that the supply of engineers selected to hold positions of responsibility in the future will come practically altogether from graduates of modern engineering colleges. The fact that engineering registration is now required in all but 13 states of the Union gives marked emphasis to this viewpoint.

The engineering profession without doubt nears the day when it will find it desirable or necessary to set up definite barriers limiting membership to those who are able to meet specified educational and professional standards. The formulation and administration of mental, special aptitude, and other tests, at or before the time of college entrance, will give a fairly comprehensive idea of the entering student's fitness for engineering study, and of his aptness for engineering practice after he has graduated.

With the appointment of Dean C. E. Seashore, of Iowa University, to the Board of Investigation and Coordination, which had been set up by the Society for the Promotion of Engineering Education, there came the suggestion that S.P.E.E. should administer the Iowa placement tests in the fields of chemistry, English, mathematics, and physics.

When the Iowa placement tests had been administered to large groups of engineering students the country over, it became apparent that they constituted, for the purposes stated, a battery of measuring instruments superior to anything yet widely tried out. A number of prominent engineering schools then adopted the plan of giving the Iowa tests in chemistry, English, and mathematics to all their freshman students at the time of entrance.

Coefficients of correlation between test scores and achievement in the specific fields of measurement in these tests fell between 0.50 and 0.77. The test results showed that the engineering teacher cannot assume that the student's high school record has much significance as an index of his success in engineering study.

The writer has developed aptitude and training tests of the Iowa type in the fields of engineering drawing and descriptive geometry. In the work of nine different freshman classes at the Missouri School of Mines since 1927, these tests have proved fully as effective in their respective fields as are the Iowa tests. The total number of students involved is slightly over 1,100. An average correlation coefficient between drawing aptitude test scores and grades in engineering drawing is 0.625. Utilizing special techniques, we have secured correlations as high as 0.81.

ENGINEERING APTITUDE A COMPOSITE QUALITY

One of the difficulties facing those who would work in the field of selection of students who are about to enter college is the lack of a satisfactory notion of engineering aptitude. Engineering educators seem to believe that there exists some specific, measurable mental trait or traits, which the engineer has and which those who are not engineers do not have—in other words, that engineers are born, not made.

As a matter of fact, there are probably few human traits to be found in absolutely zero amount in any individual. The more useful and scientific concept is that these various qualities exist in individual human beings in different degree—one quality in low degree, another in medium degree, and a third in high degree—exactly as we find various chemical elements existing in differing amounts in different chemical compounds. What we need to have and to apply is a whole group of human yardsticks (tests) that will enable us objectively and accurately to measure or to estimate the relative degree in which each of the measurable qualities exists in any one individual.

In addition to whatever other aptitudes the prospective engineer of the future must possess, it seems evident that he must have at his disposal all those aptitudes which are necessary to enable him satisfactorily to complete a standard four-year course of engineering study or its equivalent. This being true, then we already have at our command, in the Iowa placement tests, a series of relatively accurate engineering aptitude tests which can at once be made use of in every engineering college in the country. Although the "cooperative" series of tests has not been experimented with in precisely the same way that the Iowa tests have, yet the results achieved with them, where they have been employed, should mean that they could be used with as much effectiveness, perhaps, as the Iowa tests.

Eminent engineers from time to time have invested the ideal engineer with such qualities as honesty, accuracy, integrity, character, power to visualize, and interest in engineering. But for the present let us be satisfied to limit our definition of engineering aptitude so that it will include only those qualities which are objectively measurable. Of course, as time goes on we shall find it possible thus to measure more and more of the qualities we desire the engineer to have.

It must also be remembered that, in predicting success in engineering study, mental abilities are not the only factors involved. Among the other factors to be con-

sidered we should include the student's health, his life expectancy over a four-year period of engineering study, the smoothness of his home life, his objectively measured interests in the various professional fields, his interest in extra-curricular activities such as would detract from his effectiveness at engineering study, his financial re-

TABLE I. "SCHOLASTOGRAPH" OF A STUDENT WHO SHOWS HIGH APTITUDE AS A FRESHMAN, AND HIGH ABILITY IN ENGINEERING STUDY

Missouri School of Mines, Class of 1935, Student No. 35190

Results of Freshman Week Tests in Chemistry, Drawing, Mathematics, and English, Both in Aptitude and Training

Scholastic Groups	CA	CT	DA	DT	DS	EA	ET	MA	MT	DC	Av.	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_n
High 20ths	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01
	02	02	02	02	02	02	02	02	02	02	02	02	02	02	02	02	02	02	02	02
	03	03	03	03	03	03	03	03	03	03	03	03	03	03	03	03	03	03	03	03
	04	04	04	04	04	04	04	04	04	04	04	04	04	04	04	04	04	04	04	04
	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05
Medium 20ths	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06
	07	07	07	07	07	07	07	07	07	07	07	07	07	07	07	07	07	07	07	07
	08	08	08	08	08	08	08	08	08	08	08	08	08	08	08	08	08	08	08	08
	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09
	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Low 20ths	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20

LEGEND

CA, CT = chemical aptitude and training
DA, DT, DS = engineering drawing aptitude, training, and sectioning score
EA, ET = English aptitude and training
MA, MT = mathematics aptitude and training
DC = test of visualization, Mann
S_1, S_2, etc. = scholarship by semesters
S_n = scholarship in semesters beyond the eighth

sources, his personal character and appearance, idiosyncrasies, and other qualities.

In view of the foregoing, we need expect no perfect correlation (such as 1.000) in our attempt to utilize merely scholastic aptitude tests to predict scholarship in engineering colleges. We shall do well indeed, in my judgment, if we eventually get coefficients that run as high as 0.70, 0.75, or 0.80. Making such improvements in present scholastic tests as we can, we should at the same time endeavor to work out scientific means for measuring the non-scholastic qualities referred to.

MEASURING VOCATIONAL INTEREST

Professional interest is one quality that already can be measured objectively with great effectiveness. Along with many other investigators, the writer has demonstrated to his own satisfaction that this is true through administering Dr. E. K. Strong's excellent vocational interest test to a group of approximately 1,000 engineering students and teachers in Missouri schools of engineering. By the use of this test we have been able to measure the intensity of student interest in 24 of the most important fields of accomplishment, covering engineering and most of the scientific professions related to it. In addition we are able to measure interest in the professions of medicine, psychology, ministry, teaching, law, journalism, salesmanship, and certain business lines.

Just because a given student has high mental ability in general, and particularly in the field of English, physics, mathematics, or chemistry, it does not necessarily follow that he should pursue engineering study. By use of the whole battery of Iowa placement tests, the writer's drawing and visualizing tests, and scores on the Strong interest test, we have been able to devise objective methods that rather accurately locate the boy of exceptional ability whose fundamental interest is not in engineering, but in the profession of medicine, law, ministry, or teaching instead. In other cases both the interest and the measured ability are such as seem to make any professional career inadvisable.

Administration of the Strong test requires a considerable length of time for scoring. However, machine methods of scoring are in use at certain institutions, by means of which a single student's paper can be scored at a cost not exceeding one dollar. At some institutions the individual students have been willing to pay the cost of having their papers scored, and what they get is certainly worth that much to them.

Admittedly the tests now available are neither as numerous nor as perfect as they will be ten years hence. Tests of the properties of engineering materials that we use daily did not come to us all in a single year, nor are they perfect of their kind. However, we made extensive and immediate use of such tests as we had, and created the American Society for Testing Materials to refine them and devise many more. So in this business of measuring aptitudes we must not be led to expect perfection in the tests now available, when we know that if we work at the problem we shall evolve both more and better tests by 1950.

PROCEDURE AT MISSOURI SCHOOL OF MINES

The methods selected for interpreting and utilizing the test scores and results already accumulated, are just as important as the choice and administration of suitable tests. We have not known how best to use the results which should be made to live. The Missouri School of Mines is one of those institutions in which the aim has been not only to experiment with and develop aptitude tests, but also to make the greatest possible use of the results attained. The principal features of this system will now be described.

At the Missouri School of Mines the testing of freshmen is begun one week in advance of the regular registration day. During this period, called "freshman week," and under the general supervision of the registrar, the departments of chemistry, English, and mathematics administer the respective aptitude and training tests in the Iowa placement series, and the engineering drawing department administers the writer's locally developed drawing aptitude test and the Strong interest test. It is possible to score all the placement tests rapidly; and by Saturday of freshman week scores on all the placement tests given are usually available at the registrar's office.

On the basis of the information so secured it is possible to set up superior, mediocre, and low sections in each of the departments involved, so that instruction appropriate to the different levels of ability may be given during the

ensuing term. The department of physics uses the same type of program with its sophomore courses. By the middle of the semester it is possible to assemble results of all the testing, including Strong interest test scores, on cards (variants of the psychograph) which we have named "personographs." These are in fact maps of the interests, scholastic ability, and personality of the students, which permit quick appraisal of the whole mental make-up so far as it has been measured.

In order to construct charts of this kind, some rapid, practical, and convenient method of converting raw test scores into comparable standard measures is necessary. To meet these special needs the writer devised a system of vigintile (twentieth) scores ("V-scores" for short) which has proved to be exceedingly flexible, convenient, and useful in the program described. If raw scores on any test are sufficiently well distributed, it is possible to select those students whose scores place them in the top twentieth on a given test. In our system this top twentieth is numbered "one," "01," or "V_1." In like manner students in the lowest twentieth may be selected, that is, in "twenty," or "20," or "V_{20}."

TABLE II. "INTRESTOGRAPH" OF A STUDENT WHO SHOWS HIGH SCIENTIFIC AND ENGINEERING INTEREST COUPLED WITH HIGH ABILITY

Missouri School of Mines, Class of 1935, Student No. 35190

Interest Groups	Engineer	Chemist	Physicist	Sc. Farmer	Math'tician	Architect	Dr. of Med.	Psychol'gist	Artist	Teacher	Cert. Pub. Acct.	Pers. Mgr.	YMCA Phy. Dir.	Minister	Lawyer	Journalist	Ins. Salesman
High 20ths	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01
	02	02	02	02	02	02	02	02	02	02	02	02	02	02	02	02	02
	03	03	03	03	03	03	03	03	03	03	03	03	03	03	03	03	03
	04	04	04	04	04	04	04	04	04	04	04	04	04	04	04	04	04
	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05
Medium 20ths	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06
	07	07	07	07	07	07	07	07	07	07	07	07	07	07	07	07	07
	08	08	08	08	08	08	08	08	08	08	08	08	08	08	08	08	08
	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09
	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Low 20ths	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20

Remarks: The long sloping line inclined down to right shows predominance of scientific over humanistic interests.

These "V-scores," being readily understood, are very convenient if one desires to correlate the scores on two or more tests. In practice, the V-scores, or twentieths of the class, are very readily determined from a high to low tabulation of the scores and student names on any given test. If, for example, there are 200 students in a freshman class, then there will be ten students in each of the twentieths. These groups of ten may be rapidly separated on the list by drawing pencil lines between successive groups.

If we now desire to construct a graphic picture of student achievement, or a "scholastograph," on a whole battery of tests, we need only print on a 5 by 8-in. card vertical columns of figures progressing from 01, 02, 03, etc., at the top to 17, 18, 19, and 20 at the foot (Table I). The high, medium, and low twentieths show respectively high, medium, and low scholastic ability. A symbol such as "CA," "DA," etc., placed above each separate column, tells what test that column stands for. A card with such a group of columns, one for each test in the battery, is provided for each student taking the tests. A small circle is drawn around the appropriate V-score number in each column for the individual student for each test of the battery he took, and we then have pictured to the eye what he did on the whole battery. We can select the median V-score value by eye and indicate this on a separate column provided for the purpose. If we desire the arithmetic mean in place of the median, another column enables us to picture this also.

We have found it possible to represent Strong interest test scores in the same manner on "intrestographs," as we call them—5 by 8-in. cards having appropriate columns of figures for marking the V-scores, one column for each different profession in which interest is measured. The form shown in Table II provides for graphic representation of the intensity of student interest in the various professions shown at the tops of the columns.

The "personograph," Fig. 1, devised by the writer, provides a means of showing on a single polar chart all the measured qualities of the individual student, including mental abilities, special abilities, personnel ratings, term-by-term scholastic records, and intensity and diversity of professional interests. Each small sector of the chart is reserved for a single test or some one measurement made. High ability is indicated if the individual test sector is completely shaded in from inner to outer zone. Low ability is shown whenever the sectors are only partially shaded in, starting from zones nearest the center of the chart.

Using such zones on the chart, it is possible to record in what twentieth the student should be classified in each test or measurement made; and one can also read in what quarter of the class, or other division, he belongs. Student 34160, shown in Fig. 1, had high mental ability, high powers of visualization, a good scholastic record, and high interest in scientific and engineering fields. His interest in the humanistic fields, like that of many practicing engineers, was relatively low.

TESTS PROVE EFFICIENT AND VALUABLE

The use that can be made of such a testing program in predicting graduation from an engineering course after four years of engineering study is suggested by Fig. 2. The tests were given at the beginning of the period, before students had been in any classes. Students in the top horizontal row of the chart are those who rated in the top twentieth of the group taking the Mann drawing aptitude test during freshman week, the fall of 1935, before students had entered any class. The bottom horizontal row has in it all students who rated in the lowest twentieth on the same test. Students in intermediate horizontal rows rated in the intermediate twentieths on the test. The V-score norms used in this chart were determined by combining the scores of all students who took the tests in the fall of 1931 and in that of 1932. This will explain the inequality of the number of students

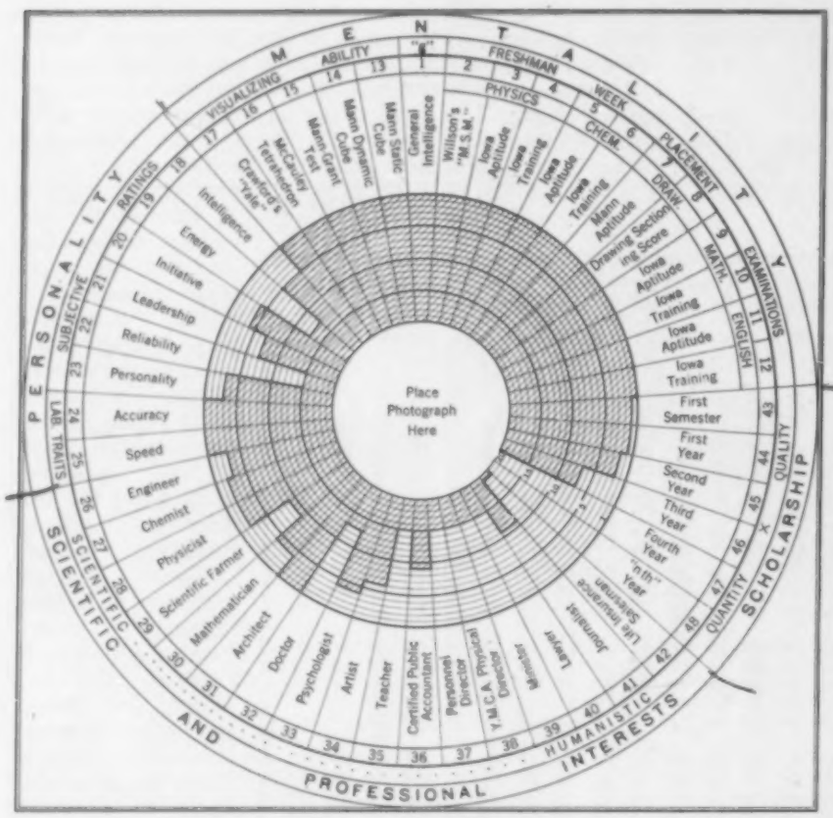

FIG. 1. POLAR PERSONOGRAPH OF A HIGH GRADE ENGINEERING STUDENT
Missouri School of Mines; Curriculum, M.E.; Class of 1934; Student No. 34160

appearing in the various horizontal rows, or twentieths.

Full squares on the chart represent individual students who graduated regularly in eight semesters. Full circles are for students who did not graduate with their own groups, but had either already graduated, or would graduate the following May, all in their own individual eight-semester periods, although delayed for financial reasons or for causes other than poor scholarship. Hollow circles are for students who are out of school, but who passed their work with or above graduation standards while they were there. Two split hollow circles are for superior students who died. Hollow squares to the left of the vertical line are for students who either failed or had grades below graduation standards. Most such students have left school.

On the basis stated, all the students to the left of the heavy vertical line are to be rated as scholastic failures in this institution. Those to the right of the vertical line, excepting the two who died, are scholastic successes. Students who had transferred to this school from other schools, who did not take the placement tests, are not included in the chart. A later survey will enable us to show on this same chart those of the graduates for the past six years who have entered the profession and achieved success.

Inspection of the chart, Fig. 2, shows among other things the following: (1) Of the group considered, 84 per cent of all students graduated regularly were from the top half of the class as selected by the drawing aptitude test; (2) all students not yet graduated, but nearing graduation or already graduated but not with their own group, are likewise in the top half of the class as set up by the test; (3) 53 per cent of all graduates came from the upper quarter of the class; (4) 77 per cent of the lower half of the class were scholastic failures; (5) 74 per cent of all failures for the entire class came from the lower half of the class; (6) two exceptional students (1 per cent of the class, who undoubtedly would have graduated had they lived) died.

I have similar charts for each separate test of the Iowa series used, and for pooled scores on all the tests. Sets of charts of the kind covering eleven years of study, and particularly for the last six successive graduating classes, exhibit practically the same effectiveness for the tests. We think the charts and these studies show that a pre-college selection of superior students adapted to succeed in engineering study is altogether possible at this time, and that the Iowa and Missouri placement tests, supplemented by the Strong vocational interest test, form a valid basis for such selection. The "cooperative" tests could without doubt be used just as effectively if desired. Furthermore, qualities measured by many other available objective tests could be added to the charts we have shown, provided that raw scores on such tests permit conversion into the V-score system we have used.

Lastly, students who have been measured by the methods described are granted free access to their individual records, and most students seem to find the charts of considerable use and interest. Many desire to have copies of their personographs to aid them in deciding whether or not to continue in engineering study; what branch to elect if they remain in engineering; and what professional field to enter if they decide they are out of place in engineering. The setting up of superior sections enables the teacher to lay out the work with considerable assurance on the basis that he is teaching a group containing most of the men who will eventually graduate. He can, if he will, supply much course material of a professional and cultural nature that could not be introduced into the ordinary type of classroom work. Such student groups may also hold valuable discussion periods.

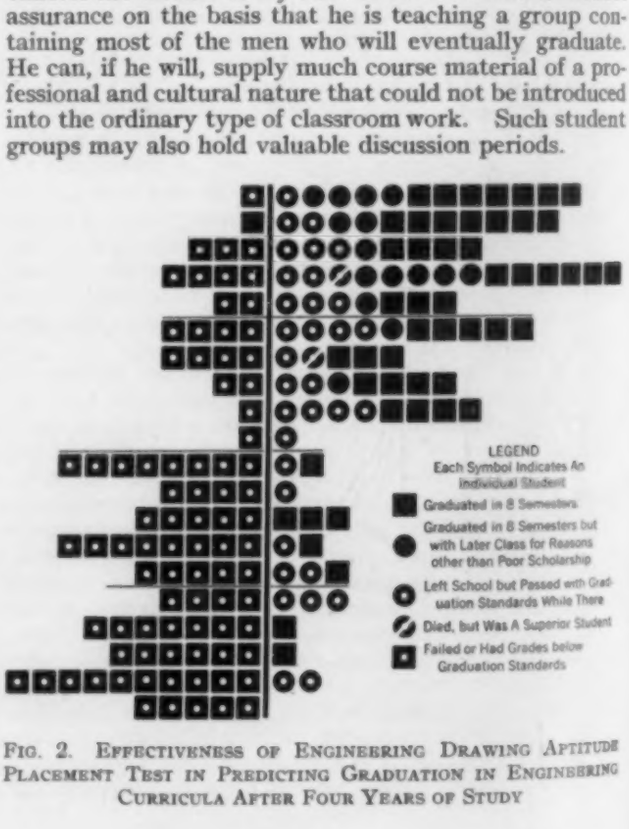
LEGEND
Each Symbol Indicates An Individual Student
Graduated in 8 Semesters
Graduated in 8 Semesters but with Later Class for Reasons other than Poor Scholarship
Left School but Passed with Graduation Standards While There
Died, but Was A Superior Student
Failed or Had Grades below Graduation Standards

FIG. 2. EFFECTIVENESS OF ENGINEERING DRAWING APTITUDE PLACEMENT TEST IN PREDICTING GRADUATION IN ENGINEERING CURRICULA AFTER FOUR YEARS OF STUDY

European Practice in Reinforced Concrete

Lightness and Daring Characterize Arch Design on the Continent and in England

By DAVID C. WILLIAMS

BRIDGHAM FELLOW FROM THE UNIVERSITY OF OREGON TO COLUMBIA UNIVERSITY, NEW YORK, N.Y.

PRODUCTS of an older civilization, it might be expected that structures on the continent of Europe and in England would express in form and material a certain conservatism. But this explanation does not adequately account for the boldness of conception, coupled with technical skill of a high order, which has flung extremely light and graceful reinforced-concrete arches over many French gorges, to mention only one illustration of the state of the art on the Continent. A similar need in this country would no doubt have been met by a less beautiful although possibly more economical steel structure, at least until recent years. The long-span parabolic roof arch is another interesting European development. In the following article Mr. Williams, member of the Columbia University Student Chapter, brings observations made during his work at Oxford University to help in analyzing the influences responsible for the marked differences between American, Continental, and English practice in reinforced concrete design and construction.

EACH country develops that particular kind of engineering which best suits its needs. The United States, expanding with incredible rapidity in the past generation, made most extensive use of steel construction. It was rapid, cheap, and easily calculated—indeed, the pin-jointed type of construction held the American field for many years by reason of its simplicity. To be sure, it involved heavy maintenance charges, or the possibility of heavy maintenance charges, and it all too often left much to be desired in beauty. But these considerations were of minor importance, as the huge cost of carrying charges on idle land while great skyscrapers were rising permitted only the most rapid sort of steel construction. Thinking and practicing steel, the American engineer became its leading specialist.

The European engineer likewise faced expansion, but of a more leisurely sort. He worked in a cultivated and ordered environment, where many people insisted that new bridges and buildings should not do violence to the beauty of the old. Permanence and grace were matters of great moment to him. He naturally turned his attention more to reinforced concrete. Applying every resource of science and ingenuity, he became as proficient in concrete as his American fellow-worker in steel. Indeed, the English engineer did little if anything in steel until after 1880, and then, having time to spare, he proceeded directly to rigid-frame construction.

TABLE I. COMPARATIVE PRICES OF BUILDING MATERIALS AND LABOR IN LONDON, PARIS, AND NEW YORK

	London	Paris	New York
MATERIALS			
Washed sand, per ton	$ 1.39	$ 1.19	$ 0.75
Gravel, per ton	1.22	1.39	1.40
Portland cement, per bbl (with sacks)	1.65	2.61	2.30
Reinforcement bars (⅜-in.) per 100 lb	1.87	...	2.50
Lumber, per million fbm (sawn)	47.00	48.00	33.00
WAGES			
Carpenters, per hour	0.30	0.40	1.40
Building laborers, per hour	0.30	0.33	0.82½

Prices as of December 1935, Reduced to American Units and Monetary System, at the Exchange Rates of One Pound at $4.92 and 15 Francs to the Dollar. English Data by Courtesy of *Concrete and Constructional Engineering*, London; French by Laboratories de Bâtiment et des Travaux Publics, Paris. Prices Should Be Taken as Only Approximate, Since There Are Individual Differences in Conditions of Delivery and Other Factors.

Meanwhile, the American engineer tended to overlook advances in foreign lands because concrete construction came rapidly to the fore in his own country. It was not perhaps until Philip Aylett and P. J. Markmann made a long and detailed report on European practice (see G. A. Hool's *Reinforced Concrete Construction*, Vol. 3, Chapter 34) that it became apparent how far Europeans had advanced. The light, spidery bridges they described must at first have seemed fantastically daring, almost reckless, compared with the massive American designs of that day.

EUROPEAN METHODS INTRODUCED HERE

The progress of time and the slowing up of building in the United States, giving engineers leisure for more difficult analyses, have afforded opportunity for the introduction of a great many European methods. But important differences still remain, due in part to national prejudice and in part to economic and social conditions, which distinguish American practice from Continental, and to a lesser extent, from English practice.

These differences are produced by the operation of certain economic, scientific, and esthetic factors. Some notion of the prevailing prices of labor and materials in Europe as compared with those in the United States is given in Table I. If London, Paris, and New York prices are taken as reflecting typical English, Continental, and American conditions, respectively, it will at once appear that while the prices of materials are roughly equivalent, European wages are but a fraction of the American standard. Accordingly the European engineer can well afford to pay for the labor involved in building elaborate forms in order to realize the maximum economy of material. The high price of lumber is a disadvantage which is overcome to some extent by using logs with bark removed whenever possible, and by repeated use of forms, which are handled with extreme care. When concrete first appeared, there was still

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PARABOLIC CONCRETE ARCHES AT ORLY AERODROME

These Hangars for French Dirigibles Are 164 Ft High, 230 Ft Wide, and 984 Ft Long

a sound tradition of stony masonry; the hinge, for instance, appeared in stone before it did in concrete. From the scientific point of view, the comprehensive tests made by the Austrian Society of Engineers and Architects in 1890 placed design on a sound basis almost from the beginning. The technical training of the European engineer was more thorough. The presence among the people of a rather widely diffused good taste in esthetic matters often required the graceful arch,

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INTERIOR OF SAINT JOAN OF ARC CHURCH, NICE, FRANCE

Three Elliptical Arches of Rough-Cast Concrete Produce This Harmonious Perspective. The Design Is Based Upon Eleven Ellipsoids. Parts of Ten Appear in the Photograph, the Eleventh Being Behind the Camera, at the Main Entrance

when from the standpoint of strict economy some other form might be preferable.

European innovations are legion. Some have gone over into American practice, but others seem still to be considered too radical. Few Americans would think of building a bridge on a floating foundation, fewer still would place it on a floating foundation at one end and on rock at the other. Yet this has been common practice in France. Among the innovations first made in Europe were a great variety of hinges, including the flexural—most economical form of all; cellular construction, by which bridges became "three parts of air to one part of concrete," in the phrase of one engineer; the division of solid arches into blocks and voussoirs, and the pouring of concrete separately in these compartments; and bowstring and open-web girders. Latest and most interesting is the parabolic arch as applied to roofs. The parabola is the natural resultant of the force of gravity and a constant horizontal force. This principle was beautifully incorporated in the Lalique fountain at the 1924 Paris Exhibition of the Decorative Arts, where the sharp vertical parabola of the fountain itself harmonized with the broad flat curves of the water issuing from the jets. Perhaps the most famous structures making use of this arch are the hangars built by the French engineer Freyssinet at Orly. A number of modern German churches show this arch. The designers of the great hall at the Brussels Exhibition of 1934 developed still another form of arch, which they claimed was even more economical of material.

FRENCH ARCH BRIDGES REACH CLIMAX AT CASTELMORON

The daring of the French engineers in reinforced concrete bridge design is widely known. It reached its highest point in the Castelmoron Bridge, which has a sheer span of 470 ft. The designer, Freyssinet, stated that he saw no reason why still longer spans should not be possible. Many American engineers remain skeptical of such bridges, feeling that increasing creep and yield will have disastrous effects with the passage of the years. Yet all French bridges are tested with great care at frequent intervals, and as yet there have been no signs of failure.

From the beginning the French have enjoyed two great advantages. The old French building regulations, valid from 1909 to 1934, were limited to the statement of rules much less formal and more flexible than those of the American codes. In particular, the permissible compressive stress in concrete, instead of being set at some arbitrary figure, was put at 28 per cent of the ultimate strength at 90 days. Skill and ingenuity in the improvement of concrete were at a premium. It became standard practice to use high-strength concrete at points exposed to unusually great stresses, and to economize with the cheaper and weaker grades at less important points. Furthermore, these liberal rules were not available to everyone, but only to engineers specially titled *Ingénieurs des Ponts et Chaussées*, the thoroughness of whose training justified reliance on their judgment.

The position of England in reinforced concrete construction is distinct from that of the Continent. English engineers, whenever they crossed the Channel, saw the works of their French comrades, and each new enterprise was reported in detail in the English technical press. A great many French engineers did work in England, and still more English engineers worked for the licensees of the various patented French systems. Yet English practice did not advance as rapidly. Natural conditions made building enterprise less ambitious in England than in France; there were not nearly so many wide rivers to span, and foundation conditions in London discouraged heavy construction.

Another great obstacle was the conservative English temperament. In common with all Continental engineers the English until recently used smooth bars for reinforcement. Party walls were allowed in office buildings, and the owner of the property had the right to extend his foundations beneath the surface of adjoining properties. While the old London County Council code did not actually forbid flat-slab or mushroom-column construction, it made no mention of them, with the result that the first warehouse making use of these highly economical forms was completed as late as 1934.

PIGEAUD'S METHOD OF SLAB CALCULATION

When the method of M. Pigeaud—well summarized by G. Dunn in "Statics of Bridge Design," *Concrete and Constructional Engineering*, for January 1934, page 15—

was introduced into England, practicing engineers welcomed it as offering great economies in concrete construction. It was essentially a method of calculation of slabs under a given load concentration from the partial differential equations for the flexure of thin plates, the plates being regarded as of isotropic material. The difficulty of course is that this last assumption is of doubtful validity, especially when there are two systems of reinforcement at right angles to each other, one much lighter than the other. But similar doubts may be cast upon any method of stress analysis; they are all approximate summaries of experience.

FREE-RIB OPEN-SPANDREL ARCH BRIDGE AT BERWICK-UPON-TWEED, ENGLAND
The Concrete Ribs Are of Hollow Cellular Construction Throughout the End Thirds of Their Length

Once the calculated curves are drawn, the application of M. Pigeaud's method is simple in the extreme. For example, assume that

a = the lesser side of the slab
b = the greater side of the slab
t = the thickness of the floor finish
b_w = breadth of wheel
b_c = breadth of contact, assumed in England at 3 in.

The following empirical factors can be derived for use in design. If the circular plane of the wheel is parallel to the side b,

$$u = b_w + 2t, \quad \text{and} \quad v = 3 \text{ in.} + 2t.$$

If the circular plane of the wheel is parallel to the side a,

$$u = 3 \text{ in.} + 2t, \quad \text{and} \quad v = b_w + 2t.$$

The quantity u is measured in the same direction as a; the quantity v in the same direction as b. The first set of equalities is employed if the circular plane of the wheel is parallel to the greater side b, the second if it is perpendicular. Curves are given for a number of different values of a/b, relating a quantity M_1 to u/a, and M_2 to v/b. Finally,

M = maximum moment across span a = $(M_1 + 0.15M_2)P$

M' = maximum moment across span b = $(M_2 + 0.15M_1)P$

where P is the given concentrated load.

The response of the authorities to the introduction of this new method was typical of their reactionary attitude. The Ministry of Transport for years had specified for concrete-slab bridges a load of two 11-ton wheels spaced 12 in. apart, probably higher than that of any other country. When Pigeaud's method made it possible to secure the same safety factor in longitudinal and transverse directions and to economize on material, it was decided to specify a 20-ton wheel load of similar width and contact to that of a standard train. By this change most of the economies possible from the new method were nullified. Further, a new equivalent loading curve was introduced for spans of less than 10 ft, based on bending moments still higher than those due to a 20-ton load.

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THE CASTELMORON BRIDGE HAS A CLEAR SPAN OF 470 FT
The Inclined Hangers Are Said to Be So Placed That Moments in the Arch Ribs Proper Are Almost Entirely Eliminated

Nevertheless, the economics of construction in England, where labor is relatively as cheap

as on the Continent, overcame the national conservatism to some extent. Bowstring girder bridges are common; among them are those of Astmoor, Stowe, Etive, and Foryd. The Astmoor structure is composed of two bowstring girders resting on rocker and roller bearings. The Findhorn Bridge employs a truss approximating the Vierendeel type to a certain extent, and producing the effect of an open-web girder. Free-rib open-spandrel

AN IRON SUSPENSION SPAN REPRODUCED IN CONCRETE
This Unique Bridge Is Located at Montrose, England

construction is increasing. Many new bridges are of this type, such as Calverley, Redbridge, and Derwent, for example.

To this class belongs the Berwick-upon-Tweed Bridge, completed in 1928, which includes a 361½-ft arch, the longest in England. The arch spans consist of four concrete ribs, which, although solid for the middle third of each span, are of hollow cellular construction throughout the end thirds of their length. Features of special interest are the heavy wind bracing and the manner in which the arches are carried through at the piers, producing a pleasing effect of continuity and reducing the size of the piers to a minimum.

Of sharply contrasting type is the new bridge at Wakefield. Here the flood level is within a few feet of the desirable road level, and to maintain the maximum opening during flood, with minimum obstruction by piers, it was decided to construct a bridge with a perfectly flat soffit on piers of minimum thickness. Studies of comparative costs proved this form to be more economical than the arch type. The four river piers may be considered as two pairs, each pair carrying a section of the bridge which spans between the pairs, cantilevering to some extent on each side and forming a sort of table with projecting ends, the gaps being filled by slab-like construction.

The prize oddity among British bridges is the one at Montrose. Here an iron suspension bridge formerly stood. The designer, reluctant to disturb old and happy memories, has apparently frozen the iron into concrete. Whatever the cause, the majority of British bridges are not nearly so pleasing to the eye as the French.

LONDON BUILDING ACT IS LIBERALIZED

English engineers were not content with their rigid codes. In 1934 a committee examined the London Building Act and declared: "The regulation of construction down to the smallest detail by rigid statutory provisions is, in our view, an anachronism which has already wrought untold harm on building in London." Accordingly, the new London County Council building code was enacted in the same year. Of special interest is the provision for three grades of concrete, an "ordinary grade," a "high grade," and a "special grade," with permissible stresses, for a 1:2:4 mix, of 750, 950, and 1,200 lb, respectively. The three grades are distinguished principally by the degree of control of concrete quality that is demanded. The use of higher stresses accordingly depends on the care taken in carrying out the work. It was required that a structure in which the special grade is used should be designed and calculated as a continuous monolithic framework. The steel tension permitted was raised to 18,000 lb, and for mild steel with a yield point of not less than 40,000 lb, to 20,000 lb. The modular ratio was raised from 15 to 18. The code (see *A Handbook on the Code of Practice in Reinforced Concrete*, by Scott and Glanville, London, 1934) provides a safety factor of 3.75 for concrete and 2.95 for steel, on the theory that when the steel yields, a part of the stress is taken by the concrete. In line with modern practice, Pigeaud's method, previously mentioned, is recognized, as is the method of Dr. Marcus for square slabs.

Discussion and practice of the new code began promptly. Interest naturally centered in the special grade of concrete and the possibilities it offered for light, open construction. It was pointed out that no suitable aggregate might be available at an economic price or that if only one company were able to furnish it there might be considerable delay. The testing requirements were regarded as very stringent, since construction apparently could not begin until the tests, requiring a number of days, were completed. Moreover, it was realized that the design of continuous monolithic structures would involve extensive office work. Nevertheless, interest in rigid-frame construction was greatly stimulated by the new code. In the first year many special concessions were granted, and some were incorporated in the code by amendment.

A new field for reinforced concrete in England is low-cost housing. The requirements of economy and sound-proof walls are readily met by concrete. The Cement Marketing Company, Ltd., conducted a competition in the design of reinforced-concrete working-class flats, which was decided in April 1935. The winning design goes very carefully into the matter of economic spacing of columns, having regard at the same time to the best arrangement for the various apartments, and arrives at the interesting solution of setting the columns in three staggered rows. This field, relatively unexplored in America, may acquire more importance when we attack our housing problem on a large scale.

Track Studies for Speeding Up Trains

Proper Treatment of Track for Fast Passenger Traffic Involves Much Theoretical Preparation

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The Santa Fe's 3,600-Hp Diesel-Electric Locomotive
This Powerful Unit Is Designed to Haul a 10-Car Passenger Train as Fast as 98 Miles per Hr

PASSENGER trains traveling at speeds as high as one hundred miles an hour require high-speed track. Although such track is only one of the factors that must be closely studied in preparing for operation on reduced time schedules, it is very important.

A more complete list of the principal factors involved would include dead weight and resistance of the train; quality of track; number of station stops, railroad crossings, and highway crossings; arrangements for passing trains; spacing of signals; grades; and curvature. Given a locomotive with ample power, the problem of reducing time schedules becomes one of eliminating as many of the speed-restricting elements as possible.

FACTORS LIMITING THE SPEED OF TRAINS

The dead weight of locomotive and cars is a drag against power which directly affects speed. Not much can be done toward reducing weight in a locomotive, because most of the weight is required to furnish adhesion and to prevent slipping on the rails. The usual passenger car weighs from 15 to 80 times its pay load. Some progress has been made in reducing passenger car weights, but on the majority of roads there is still room for very great improvement in this respect. As the present equipment is worn out and retired we may expect to see a decided trend toward less weight in equipment.

Train resistance consists of journal friction, atmospheric resistance, and normal rolling resistance between wheel flange and rail. Improved journal bearings, streamlined cars, and improved rail contours have contributed to its reduction.

If the track is rough, excessive resistance results, due to oscillation and concussion of the wheels; furthermore, operating at high speeds over such track is dangerous. Thus light-weight rail must be replaced with heavier rail, which lessens the likelihood of track failures and is more easily maintained under fast or heavy traffic. Rail lighter than 110 lb per yd is rapidly becoming obsolete on heavy-traffic railroads. Deferred maintenance, as reflected in poor line and surface, must be caught up, and track must be closely patrolled to minimize the danger of accidents from track failures.

Even on extended runs, it is necessary to have a certain number of station stops for taking on fuel, inspecting equipment, and handling a restricted amount of local business. These stops are limited as much as possible on long, high-speed runs. Little can be done to avoid slowing down for railroad crossings, interlocking plants, and turnouts at the end of double track, but often a rearrangement of facilities will reduce the loss of time.

Grade separation is the obvious means of eliminating restrictions due to crossing highways and streets at grade. If separation is impracticable, automatic indicator protection is essential. Town officials can sometimes be persuaded to lift speed limits if adequate crossing protection is maintained.

On single-track lines, delays may be reduced by constructing additional passing tracks or a second track, or by installing spring switches. In practically all cases high-speed passenger trains have rights over trains of other classes.

Signal spacing must sometimes be increased, as higher speeds lengthen the distance required for braking. At highway crossings, circuits must be lengthened to maintain an adequate time interval for the operation of warning signals.

Rising grades restrict acceleration in proportion to the rate of rise. Descending grades beyond certain limits must be operated at reduced speeds in order to keep trains under safe control. Appreciable reduction of grades is rarely possible without very extensive relocations of line, which are justified only by large savings in operating costs or gains in time.

Curvature, which includes sharpness of the curve, amount of superelevation, and the condition of transition between tangent and curve, merits much study. It is one of the

CERTAIN fast passenger trains now operate at speeds approximating 100 miles per hr, as compared with the former maximum of 60 to 70 miles per hr prevailing only a few years back. Standards for curves had been fixed much earlier, and in order to provide for higher speeds the railroads are lengthening spirals, increasing super-elevation on curves, and where necessary, reducing curves and relocating lines. Before putting such changes into effect, however, it has proved desirable to know in a general way what speeds will be attained in each direction over the entire line. In the following article, Mr. Mercer explains the development of the theoretical speed diagrams used for this purpose. Sufficient general discussion of the subject is included to make the article of interest to other than railroad men.

MULTIPLE-TRACK HIGH-SPEED MAIN LINE ON THE SANTA FE

outstanding speed-restricting factors, and curve treatment usually yields good results for the money expended.

ADAPTING CURVES TO VARIOUS CLASSES OF TRAFFIC

"Equilibrium speed" on a super-elevated curve is the speed at which the resultant of forces passes midway between the rails and the lateral pressure against the rails is zero. If it were possible for all classes of traffic to be operated at the same speed in both directions while passing over a curve, the ideal condition of smooth passage and minimum rail wear could be obtained by elevating for "equilibrium." In that case, there would scarcely be a limit to the speed that could be provided for by the use of sufficient super-elevation. But a section of curved track must usually handle several classes of traffic, operating at different speeds. The speeds may be further modified by grades which vary according to the direction. A slow train passing over a sharp curve that is elevated for a much higher speed tends to throw the track out of surface and to cause excessive wear on the inside rail, and a limit must therefore be placed on super-elevation. It has been found that 6 in. is about the maximum that will permit proper maintenance of good track for all classes of traffic. The usual formula used to determine the super-elevation required to provide equilibirum is

$$e = 0.00066S^2D$$

where e is the super-elevation in inches, S the speed in miles per hour, and D the degree of curve.[1,2]

Safety and comfort limit the speed at which a passenger train may negotiate a curve. Any speed that gives comfortable riding on a curve is well within the limits of safety. Experience has shown that the usual passenger coach or Pullman car still rides comfortably around a curve at a speed which would require a super-elevation about 3 in. higher for equilibrium. As far as high-speed traffic is concerned, it may therefore be said that passenger comfort governs train speeds on curves, and a limited amount of traffic may be operated over curves at speeds somewhat greater than equilibrium speed. Advantage is taken of this condition in operating high-speed trains on track that must also carry slower traffic.

The problem of balancing speeds and super-elevation on curves so that all classes of traffic may be operated safely and efficiently, is one that has received a great deal of study. Prior to the advent of high-speed trains, most railroads had standardized practices which experience had shown to be best for the particular classes of traffic and speeds handled. Such practices were usually based more upon expert judgment than upon any definite analysis of the various factors involved. Increasing passenger train speeds 40 or 50 per cent over previous maximum speeds complicates the problem and renders former practices obsolete. Provision must be made for a wider variation in speeds to be handled safely and efficiently over the same track. In many cases, the only solution is to resort to reduction of curvature.

Converting the previous formula for super-elevation for equilibrium to one giving super-elevation for comfortable speed, we write

$$e + 3 = 0.00066S^2D.$$

Solving for S, we get

$$S = \sqrt{\frac{e+3}{0.00066D}}$$

In comparing the results obtained by the use of the formulas for equilibrium speed and for comfortable speeds

TABLE I. "EQUILIBRIUM" AND COMFORTABLE SPEEDS WITH CORRESPONDING SPIRAL LENGTHS

Speed in Miles per Hour and Spiral in Feet

DEGREE	SUPER-ELEVATION											
	1 IN.		2 IN.		3 IN.		4 IN.		5 IN.		6 IN.	
	Speed	Spiral	Speed	Spiral	Speed	Spiral	Speed	Spiral	Speed	Spiral	Speed	Spiral
0° 30′ Equil.	55	0	78	105	..	...	..	...	..	...	..	...
Comf.	110	129	123	290	..	...	..	...	..	...	..	...
1° 00′ Equil.	39	0	55	75	67	135	78	210	87	290	..	...
Comf.	78	92	87	205	95	335	103	455	110	647	..	...
2° 00′ Equil.	28	0	39	60	48	100	55	145	62	215	67	270
Comf.	55	65	62	146	67	236	73	344	78	459	82	578
3° 00′ Equil.	23	0	32	60	39	90	45	120	50	165	55	220
Comf.	45	53	50	118	55	194	59	278	63	371	67	472
4° 00′ Equil.	19	0	28	60	34	95	39	120	43	150	48	200
Comf.	39	46	43	101	48	169	51	240	55	324	58	409
6° 00′ Equil.	16	0	22	60	27	90	32	125	36	155	39	190
Comf.	32	38	36	85	39	138	42	198	45	265	48	339

Equilibrium speed = $\sqrt{\frac{e}{0.00066D}}$ Comfortable speed = $\sqrt{\frac{e+3}{0.00066D}}$

Spiral lengths for equilibrium speeds are taken from the *American Railway Engineering Association Manual*, 1929, page 203. They are minimum lengths and may be increased as much as 50 per cent when this does not materially increase the cost. Spiral lengths for comfortable speeds are calculated on the basis of a runoff of 1¼ in. per sec.

respectively (Table I), it will be seen that a considerably larger increase in speed is permissible for curves of small degree than for sharper curves. For example, a 1-deg curve with 2 in. of super-elevation is good for an equilibrium speed of 55 miles per hr and a comfortable speed of 87 miles per hr; whereas a 3-deg curve with 6 in. of super-elevation, also good for an equilibrium speed of 55 miles per hr, is good for a comfortable speed of only 67 miles per hr. This means that curves of small degree will handle speeds of wider variation than will the sharper curves. Consequently, curve reduction often provides a means of handling diversified classes of traffic that cannot be cared for by any other expedient.

In order that there may be no disagreeable lurch when a train passes on or off a curve, transition curves or spirals are inserted between the tangents and the circular curve. Within the length of each spiral the radius changes from infinity to the radius of the circular curve, or vice versa, and the super-elevation changes from zero on the tangent to the full amount on the circular curve. If the transition is too short, the rapid change in elevation is uncomfortable to passengers. Spiral lengths computed on the basis of running out the elevation at a rate of about $1^1/_4$ in. per sec make comfortable riding for high-speed traffic. Table I shows spiral lengths calculated on this basis, as well as the minimum spirals recommended by the American Railway Engineering Association and applied to equilibrium speeds.

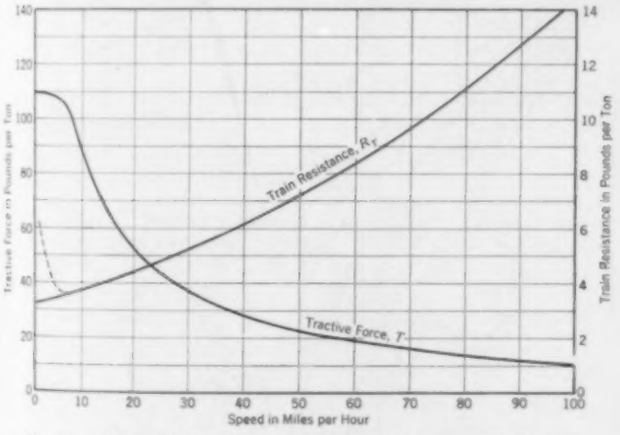

Tractive Force in Pounds per Ton
Train Resistance in Pounds per Ton
Train Resistance, R_T
Tractive Force, T
Speed in Miles per Hour

FIG. 1. SAMPLE CURVES OF DRIVER TRACTIVE FORCE AND TRAIN RESISTANCE

In preparing a line for high-speed trains, a great many spirals must usually be lengthened. This involves either slightly sharpening the circular curves or throwing them for their entire lengths, and since large throws are expensive, considerable study is sometimes necessary to hold the cost to the minimum that will give good-riding track. If throws are excessive, it may be almost as cheap to reduce the degree of curvature, and certainly operating conditions will be improved by such reduction.

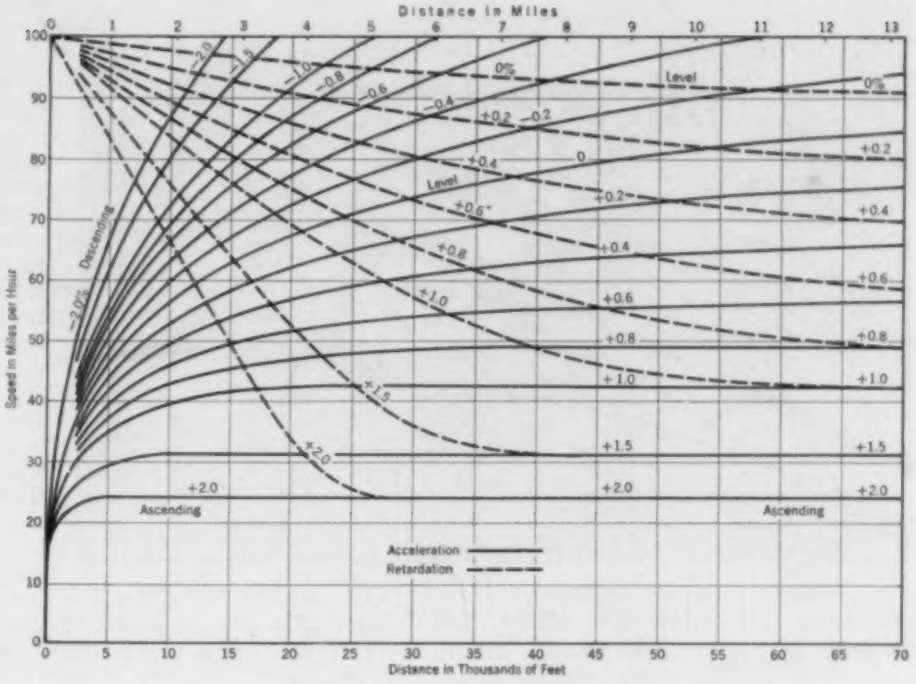


FIG. 2. TYPICAL ACCELERATION AND RETARDATION CURVES

In order to know which curves must be reduced or respiraled, it is necessary to know in a general way what speeds will be attained. A convenient method of studying the effect of various conditions on speed is to construct a diagram of theoretical speeds in each direction over the entire line.

The length l in which speed is changed from a value S_1 to another, S_2, is expressed by the formula:

$$l = \frac{70\,(S_2^2 - S_1^2)}{P}$$

in which l is expressed in feet, S is speed in miles per hour, and P is the net force per ton available for acceleration.[1] P is obtained by subtracting from the driver tractive force T, the train resistance R_T, and the grade resistance R_G, all in pounds per ton. Curve resistance is also a retarding factor, but it probably may be best considered by correcting the grade, using 0.03 to 0.04 per cent per degree of curve. This resistance is automatically cared for on compensated ascending grades, but on compensated descending grades the flattened grade is adverse to the accelerating effect of the grade so that a resistance double the amount of the compensation results.

The tractive force T at various speeds may be determined from the locomotive characteristics of boiler heating-surface, grate area, quality of fuel, working pressure, cylinder diameter and stroke, driver diameter, and weight on the drivers,[1,3] or as in the case of electric or Diesel power, this information may be readily obtained from the locomotive manufacturer. It will be found convenient to plot a curve of values of driver tractive force, such as that shown in Fig. 1.

The train resistance, R_T, may be computed by empirical formulas, such as the following:[3]

$$R_p = 1.3 + \frac{29}{W} + 0.045S + \frac{0.0024AS^2}{WN}$$

$$R_t = 1.3 + \frac{29}{W} + 0.045S + \frac{0.00034AS^2}{WN}$$

In these formulas R_p and R_t are the total train resistances on tangent track, for power cars and for trailing cars,

SUCH TORTUOUS ALIGNMENT RESTRICTS SPEEDS, PROBABLY CALLING FOR EXTENSIVE RELOCATION

respectively; W is the weight per axle in tons; N, the number of axles per car; S, the speed in miles per hour; and A,* the cross-sectional area of body and trucks. The train resistance curve shown in Fig. 1 was plotted by dividing the combined resistances in pounds for a power unit and ten trailing coaches, as computed by the above formulas, by the total weight of the train in tons, giving pounds per ton resistance. The actual curve at starting is more nearly as shown by the dotted line, but since the distances moved at starting speeds are very short, the solid line serves the present purpose.

By equating the work done in overcoming grade resistance in a given distance to the energy required to lift the train through a corresponding height, it may easily be shown that the grade resistance, R_G, is equal to 20 lb per ton for each 1 per cent of grade.[1]

CONSTRUCTING ACCELERATION CURVES

These data are then used to determine points on acceleration curves, such as those shown in solid lines on Fig. 2. Starting with zero speed, increments of length are calculated for small changes in speed, and the summations of these lengths are plotted against final speeds. A tabulation of part of the computations for one such curve is shown in Table II.

Retardation curves, such as those shown by the dashed lines on Fig. 2, are computed by the same method, except that S_1 and S_2 are interchanged in the formula.

A chart of braking distances, such as is shown in Fig. 3, is needed to plot points on the speed diagram where brakes must be applied. A formula for distance required to slow down from a speed, S_1, to another, S_2, may be derived by equating the kinetic energy of the moving train to the sum of the work done by the brakes and the work done in overcoming train and grade resistances, that is,

$$2{,}000WV_H = 2{,}000WKfl \pm 20Wgl + WR_Tl$$

Solving for l and adding the distance traveled before brakes take effect, gives

$$l = 1.467S_1T + \frac{2{,}000V_H}{2{,}000Kf + R_T \pm 20g}$$

In this formula, S_1 is the speed at the time brakes are applied; T is the time required for brakes to act, assumed as 6 sec in this case; V_H is the loss in velocity head from S_1 to S_2, computed as $0.035\ (S_1^2 - S_2^2)$; K is a constant representing the product of braking ratio and brake rigging efficiency, here taken as 0.70; f is the coefficient of brake friction, assumed to vary with speed as shown by the insert in Fig. 3; R_T is the train resistance taken from Fig. 1 for the average speed; and g is the grade in per cent.

Distances found by use of the curves will be the approximate minimum distances in which the assumed train can be stopped in an emergency. The distances required for service stops usually will be from 25 to 50 per cent greater. To find from Fig. 3 the distance required to reduce speed, add the distance corresponding to the initial speed along the dashed line to the distance between initial and final speed intercepted on the braking curve for the proper gradient.

DIAGRAMS OF THEORETICAL SPEEDS

Figs. 2 and 3 may now be used to compute speeds over the line on which the assumed train is to be operated. A sample profile is shown in Fig. 4, together with speed diagrams for operation in both directions. Such a

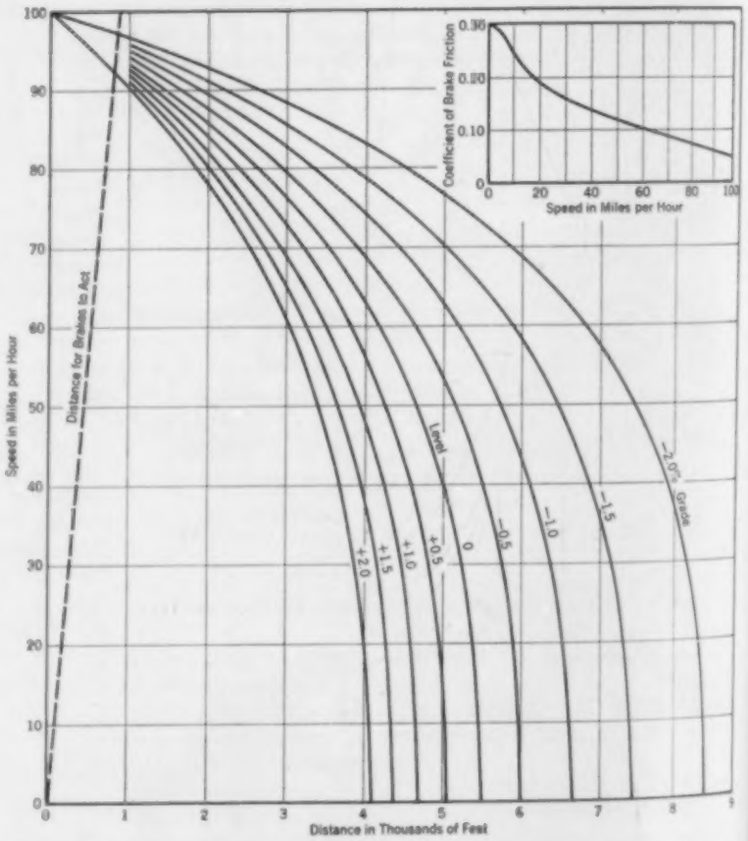


FIG. 3. CHART FOR DETERMINING POINTS WHERE BRAKES MUST BE APPLIED

diagram furnishes a fairly accurate picture of the effect of all factors which affect speed. If carefully computed, it will agree surprisingly well with the speeds actually attained in operation. Fig. 4 shows clearly the effect of grades and forced slow-downs, and emphasizes the fact that speed, once lost, is regained only with difficulty. When such diagrams are made up for existing conditions and compared with diagrams for the same line, with some of the speed-restricting conditions removed, a valuable study is provided upon which to base decisions regarding future improvement policies.

Comparative speed diagrams are useful in the study of many problems involving the improvement of track for high-speed train operation. For example, the effect of a single sharp curve in a long stretch of track is apparent for a surprising distance, and the consequent loss of time is graphically brought out. In a territory with heavy grades and many sharp curves, the grades may govern speeds to such an extent that little curve treatment is practicable; in this case the diagrams readily show which curves may be reduced profitably. They make it possible to study the advisability of drastic changes of line in a locality where less expensive treatment will result in speeds only slightly lower. They facilitate studies leading to a reasonable choice between the spending of a large sum of money to get light curvature that will adequately handle all classes of traffic, and getting along with minor improvements that will still leave many speed restrictions and high maintenance expense.

CURVE TREATMENT IN RUGGED COUNTRY INVOLVES GREAT COST BUT YIELDS GOOD RESULTS

Although these studies deal primarily with improving track for the purpose of taking care of one class of traffic only, it should not be forgotten that such improvements affect all classes operating over the line. While the saving in time for an individual train ceases to be as important in the case of slower traffic, the total saving in time and maintenance expense due to improved track conditions is, nevertheless, worthy of much consideration in view of the fact that it is participated in by a greater volume of traffic. Where the economic justification of an improvement primarily intended for high-speed trains is in question, the effect of the proposed improvement upon other classes of traffic may be the decisive factor.

No doubt railroad transportation will continue to conform to the general pattern of the times—a steadily rising curve of speed. It is difficult to picture future trains traveling at much greater speeds than those now being provided for, but the same was said a few years ago when 60 or 70 miles an hour was the maximum. As the track structure becomes obsolete, it will be increasingly necessary to study thoroughly and eliminate the conditions which impede still faster travel. Therefore it would appear to be wise to project plans somewhat farther into the future than immediate needs require.

TABLE II. PARTIAL COMPUTATIONS FOR AN ACCELERATION CURVE

SPEED S	S^2	$S_2^2 - S_1^2$	$70(S_2^2 - S_1^2)$	AVER. T	AVER. R_T	RG	$T - R_T + RG$	DISTANCE l	ACCUMULATED DISTANCE, L
54	2,916								6,260
		220	15,400	20.5	7.7	8.0	20.8	740	
56	3,136								7,000
		228	15,960	19.8	8.0	8.0	19.8	806	
58	3,364								7,806
		236	16,520	19.1	8.2	8.0	18.9	874	
60	3,600								8,680
		244	17,080	18.6	8.5	8.0	18.1	944	
62	3,844								9,624
		252	17,640	18.1	8.8	8.0	17.3	1,020	
64	4,096								10,644
		260	18,200	17.6	9.0	8.0	16.6	1,096	
66	4,356								11,740
		268	18,760	17.0	9.3	8.0	15.7	1,195	
68	4,624								12,935
		276	19,320	16.5	9.5	8.0	15.0	1,288	
70	4,900								14,223

$$l = \frac{70\ (S_2^2 - S_1^2)}{T - R_T + RG}$$, for a -0.4 per cent grade with $RG = 8$ lb.

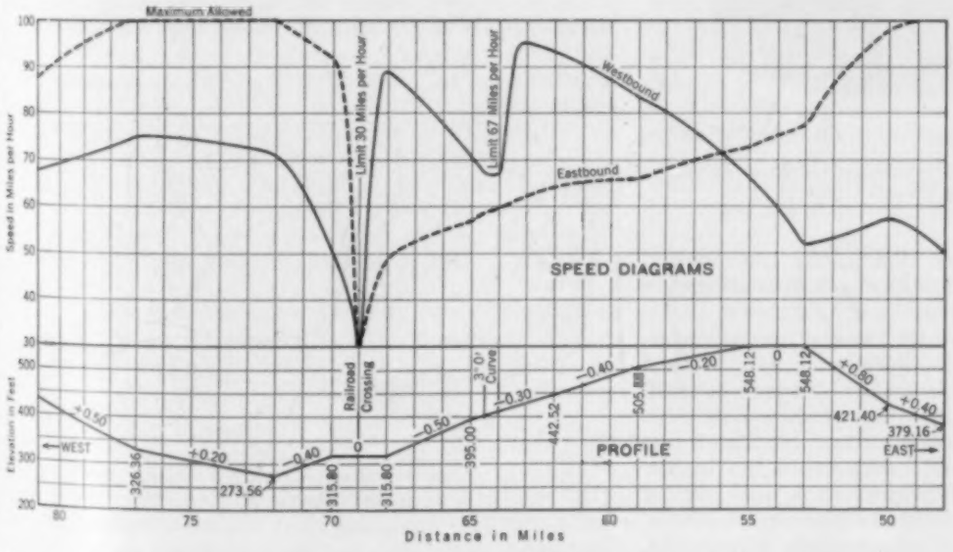


FIG. 4. A TYPICAL PROFILE OF TRACK, WITH ACCOMPANYING SPEED DIAGRAMS

REFERENCES

(1) Raymond's *Elements of Railroad Engineering*, fourth edition.
(2) *American Railway Engineering Association Manual*, 1929, Page 228.
(3) *American Railway Engineering Association Proceedings*, 1933, Page 556.
(4) A. C. Barrow, "Problems in Locomotive Acceleration," CIVIL ENGINEERING, April 1934.

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain ingenious suggestions and practical data from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Eliminating Local Stress Concentrations in Photoelastic Model

By J. E. Soehrens, R. T. Cass, *and* J. E. Sower

Juniors American Society of Civil Engineers

Respectively Assistant Engineer, Junior Engineer, and Junior Engineer, U. S. Bureau of Reclamation, Denver, Colo.

In applying a distributed load to a photoelastic model by means of shoes and thin gaskets, it is often difficult to avoid unnatural local concentrations of stress, particularly along curved boundaries. Especial interest therefore attaches to a model recently set up in the photoelastic laboratory of the Bureau of Reclamation, in which such concentrations were successfully eliminated by two new methods of loading.

The purpose of the model study was to determine the worst condition of loading of the twin concrete outlet conduit of the Bull Lake Dam, and to check a mathematical analysis of the same structure. The conduit is approximately 22 ft in width, 11 ft 6 in. in height, and 470 ft long, and is covered with 73 ft of earth fill.

The general set-up of the model is shown in Fig. 1. Water loads in the tunnels were simulated by applying compressed oxygen through rubber tubes arranged as indicated in Fig. 2. In order to simulate the external loads satisfactorily, the bakelite model was fitted snugly into a hole cut in a rectangular sheet of rubber, $^1/_2$ in. thick and 2 in. larger each way than the maximum dimensions of the model. The horizontal and vertical earth pressures were applied, by means of levers, to small steel shoes in contact with the edges of this sheet. To prevent buckling, the shoes and rubber loading frame were encased in plyboard. A clearance of $^1/_{16}$ in. between rubber and plyboard insured that none of the load would be absorbed in shear between the two surfaces.

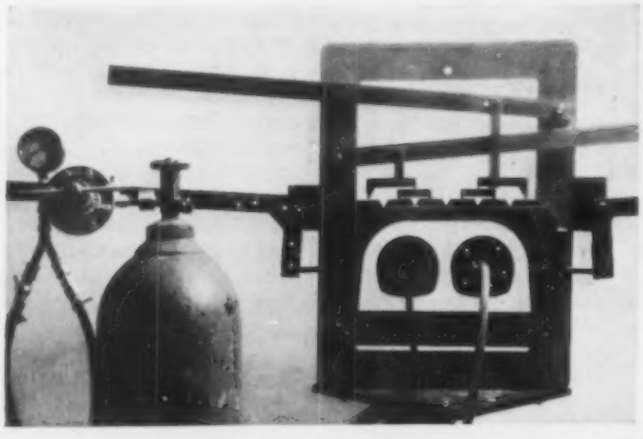


Fig. 1. Photoelastic Model of Twin Concrete Conduit

The Apparatus for Applying Load Prevented Unnatural Concentrations of Stress

The fringe patterns in an accompanying photograph indicate, by their symmetry and by the absence of local fringe concentrations along the loaded boundaries, how effective this method was in providing a uniformity of loading.

In determining the loads to apply to the model, Rankine's formula for horizontal earth pressure was used as a starting point. This indicated a horizontal pressure equal to one-third the vertical, and from this value other conditions of loading were decided upon. It was found that an increase of the horizontal load in general lowered the critical stresses, while a decrease of the horizontal load increased them. The structure was analyzed with various water loads in the tunnels themselves—with both conduits empty, both loaded with full water pressure, and only one loaded.

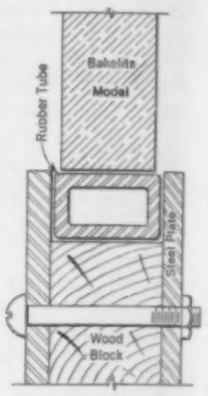


Fig. 2. Sectional Detail Showing How Water Load in the Tunnels Was Simulated

Oxygen Pressure in the Rubber Tube Can Be Varied at Will

From the isochromatic pictures, the fringe orders at the boundaries of the loaded model were converted into stresses in the prototype by the equation $\sigma_P - \sigma_Q = nC$. In this equation σ_P is the stress parallel to the boundary; σ_Q, the stress perpendicular to the boundary; n, the fringe order; and C, a calibration constant determined from a small test beam. At the boundaries, σ_Q is either zero or some known value due to the load

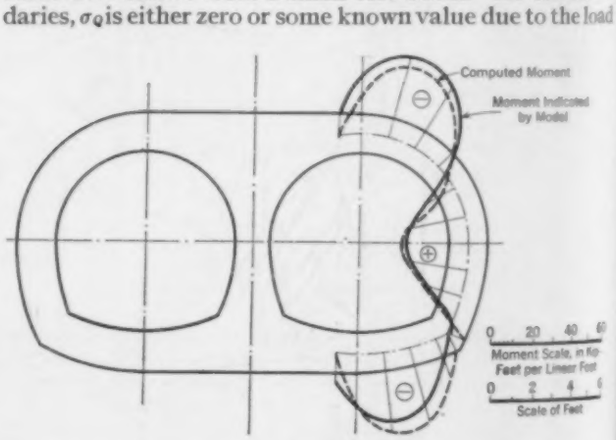


Fig. 3. Comparison of Mathematical Analysis and Experimental Results

Tunnels Empty; Horizontal Earth Pressure Taken as One-Ninth the Vertical in the Model Study, and as Zero in the Mathematical Analysis. Positive Moments Produce Tension in Outside Fiber

COMPOSITE PHOTOGRAPH OF A TYPICAL ISOCHROMATIC PATTERN, SYMMETRICAL LOADING
Note Symmetry of Pattern

on the boundary, and σ_P is therefore determinate. This method of interpreting the observations is described by Dr. John H. A. Brahtz in the September 1935 PROCEEDINGS.

Having the boundary stresses, the bending moment was determined in the thin sections by assuming a linear distribution of stress across the section. The curves of Fig. 3 show the variation between the model indications and the results of a mathematical analysis based on the column analogy. Considering the assumptions necessary in the mathematical analysis, and the experimental errors, the agreement is thought to be excellent, and a sufficient justification for relying on the mathematical analysis as a basis of design. However, the photoelastic method is a fast way of considering different loading combinations to find the worst conditions, and only a small amount of calculation is necessary to convert the photographs into moment diagrams.

This analysis was conducted in the photoelastic laboratory of the Bureau of Reclamation under the general supervision of J. L. Savage, M. Am. Soc. C.E., chief designing engineer, and K. B. Keener, designing engineer on dams; and under the direction of Dr. J. H. A. Brahtz, engineer in charge of the photoelastic laboratory, all of the design staff of the U. S. Bureau of Reclamation, Denver, Colo. The chief engineer of the Bureau is R. F. Walter, and the acting commissioner is John Page, both Members of the Society.

The Use of Celluloid in Hydraulic Models

By GAIL A. HATHAWAY, M. AM. SOC. C.E.
SENIOR HYDRAULIC ENGINEER, OFFICE OF THE DIVISION ENGINEER, MISSOURI RIVER DIVISION, KANSAS CITY, MO.

THE pyroxylin plastic commonly known as celluloid is an excellent material for hydraulic models, inasmuch as it is workable, smooth, and transparent. The material, also known variously as pyralin, viscoloid, and xylonite, is obtainable in colored, opaque, and transparent sheets, but the form best suited for hydraulic models is the transparent material manufactured in sheets of uniform thickness and quality, and polished on both sides. Commercial firms stock this type in 20 by 50-in. sheets, varying in thickness from 0.003 to 0.125 in.; thicker sheets and special shapes can be obtained from the manufacturers. Celluloid may be machined and worked by the methods usually employed in woodwork, or may be molded into irregular shapes after heating. The surface is relatively smooth; experiments conducted on the model of a tunnel for the Fort Peck Dam gave an average value of 0.0081 for Kutter's *n*.

The physical characteristics of celluloid vary considerably with changes in composition and quality of ingredients, but in general the elastic limit varies from 2,000 to 6,000 lb per sq in., and the modulus of elasticity ranges from 200,000 to 400,000. The rate of loading has an important influence on the elastic limit, ultimate strength, and modulus of elasticity, the values increasing as the rate of loading increases. The ultimate strength varies from about 4,000 to 8,000 lb per sq in., and the coefficient of thermal expansion ranges from 0.00012 to 0.00016.

The methods used in the laboratory of the U. S. Engineer Department, Missouri River Division, Kansas City, Mo., in constructing celluloid models of Tunnel No. 1 for the Fort Peck Dam are described in the following paragraphs.

CONSTRUCTION OF MOLDS

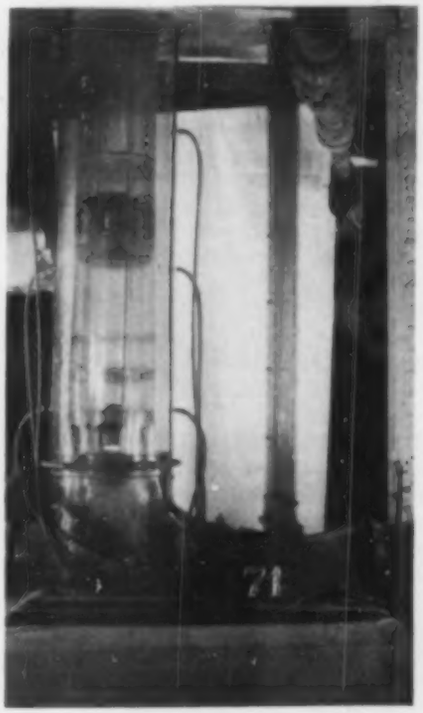
Wooden molds were used exclusively. Both Western white pine and sugar pine (Grade C select) were found to be quite suitable; they are moderately light in weight, straight grained, and workable, and change dimensions very little from loss of moisture during heating. The material was usually purchased in 2 by 12-in. boards.

In preparing cylindrical molds, the lumber was cut in strips, which were glued and nailed together to roughly approximate the circular dimension, and then turned to the proper diameter on a lathe. Molds of irregular shape were built up of laminar sections, the thickness of each section depending upon the conformation of the structure and the dimensions of the lumber available for the mold. Cardboard templates were prepared from sketches, made from the design drawings, that conformed to cross-sectional views at the ends of successive laminar sections of the mold. The blocks were then cut to conform with the templates, and the successive sections were fastened together with nails, screws, and waterproof glue. Finally, the mold was checked for general curvature and dimensions, and finished to exact dimensions by sanding, and in some cases by filling with plastic wood. Molds over or around which celluloid was to be shaped were constructed to the design dimensions, with no allowance for shrinkage in the molds occasioned by the heating required for molding the celluloid. Any minor inaccuracies resulting from shrinkage in the molds were eliminated in the final trimming and gluing together of the molded celluloid shapes.

HEATING AND MOLDING CELLULOID

For heating the celluloid, an electric oven 53 in. long, 24 in. wide, and 21 in. high, was constructed of $^1/_2$-in. asbestos board reinforced on the outside by wooden framing and cross braces. The heating unit consisted of six 750-w strip heating elements spaced symmetrically over the bottom of the oven about 1 in. above the floor. Above them was a shelf of asbestos board, arranged with ample space at the ends and sides to permit the circulation of heated air. A thermometer, reading up to 350 F, was suspended through a hole in the top of the oven at each end to facilitate frequent checking of the temperature.

In molding the celluloid it was essential that the temperature of the mold be approximately the same as that of the air in the oven. Therefore, large molds were placed in the oven when the current was first turned on. As the temperature of the oven gradually increased to that required for molding, the outer surface of the mold became heated to the same temperature. Then when celluloid was placed on the mold it was heated equally on both sides and much better results were obtained. When the larger molds were not preheated, they conducted heat away from the celluloid before it could be properly shaped after removal from the oven. Frequently the temperature at one end of the oven would become higher than at the other. An electric fan was sometimes used to circulate the air and thus distribute the heat uniformly. Satisfactory results were also secured, without a fan, by reversing the position of the molds in the oven at intervals during the heating process. With this method, however, it was necessary to make frequent inspections as the thermometer reading at the hotter end of the oven approached the molding temperature, in order to insure adequate heating of all surfaces and yet avoid burning.



A COMPLICATED INTAKE TOWER MODEL BUILT OF CELLULOID

The Flow of Water Up the Outer Tower, Through the Ports, and Down the Inner Tower Was All Clearly Discernible

Various methods of fastening the celluloid to the mold were tried. In molding long tubular shapes, it was found that 2-in. rubber bands cut from an old inner tube of an automobile tire gave the best results. For large circular shapes, where rubber bands could not be used, unbleached muslin cloth was tied about the celluloid to hold it to the mold. Because of the expansion due to heating, celluloid should not be fastened securely to molds with nails or screws.

It was possible to mold cylindrical shapes having a diameter of 12 in. or more, on laminated molds having sections spaced on a longitudinal bar at about 8-in. intervals. Close inspection was required during heating, however, for if the temperature became too high, the celluloid sagged between the laminar sections of the mold from its own weight. Cylindrical forms of smaller diameter required solid molds for satisfactory results. To accurately mold warped surfaces—for example a 90-deg bend in a 6-in. pipe—it was necessary to construct both an interior and exterior mold, with allowance for expansion in one and contraction in the other. It was found preferable to mold odd-shaped parts in several sections, for the process usually necessitated alternate heating and working of the celluloid over the mold by hand. The bend, for example, was molded in halves and later glued together. Two pairs of cotton flannel gloves provided sufficient protection for the hands during the working.

For molding cylindrical shapes under rubber bands, a temperature of 270 F was ordinarily sufficient, and quite frequently temperatures as low as 260 F gave satisfactory results. At a temperature of 280 F, celluloid begins to swell and absorb air, and bubbles appear within the sheets. If the temperature is increased far above 300 F, the celluloid will ignite and explode. It was usually found advisable to support the molds on wooden blocks in order to prevent contact between the celluloid and the asbestos shelf and lessen the danger of overheating; but in cases requiring a flexibility resembling that of cloth, the necessary temperature was secured by laying the celluloid directly on the shelf and watching it carefully.

It is possible to satisfactorily mold celluloid of any thickness into irregular forms if sufficient time is given to the operation and the molds and celluloid are inspected frequently as the temperature rises.

ASSEMBLY

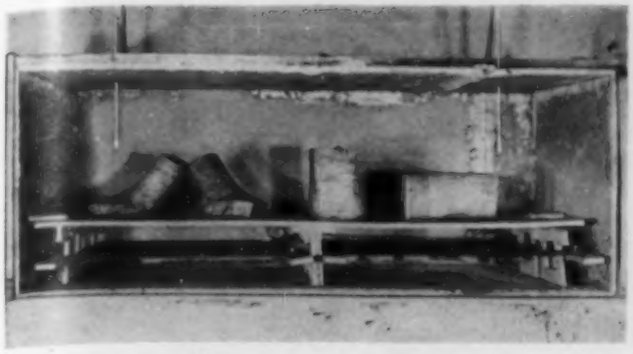
Glue for fastening the various sections together was made of celluloid dissolved in chemically pure acetone. As a solid mass of celluloid would dissolve too slowly, the material for the glue was cut in strips, crimped to avoid packing, placed in a jar, and covered with acetone. After setting for about an hour, the glue was stirred and enough acetone was added to give it a consistency similar to that of 600 W. steam engine oil. The mixture was then sealed and stored for a period of 6 to 12 hr to ensure complete dissolution of the celluloid.

Glue was used only for joining sheets exceeding 0.05 in. in thickness. Sections were united by applying glue and clamping the joint between wooden blocks for at least 2 hr. No strain was applied to the joint for a period of from 6 to 12 hr, and contact with water was not permitted before 24 hours had elapsed. If the glue was not entirely hardened before contact with water, it turned white, visibility was obscured, and the celluloid adjacent to the joint became soft and pliable. In cementing sections where a stiffening strap around the joint was not essential, the best results were obtained by using acetone applied with a small brush or syringe, instead of glue. Acetone applied in this manner was allowed to soak in between the two strips to be joined. In making butt-joints, a thin strip of celluloid was glued over the outside, and the inside of the seam was brushed with acetone until the connection was well sealed.

SPECIAL DETAILS

Celluloid sheets having thicknesses of 0.020, 0.050, 0.060, 0.075, and 0.100 in. were used in the construction of the Fort Peck tunnel model. Sheets having a thickness of 0.100 in. were used in sections subject to considerable compressive or bending stress. For structures requiring unusual distortion, a thickness of 0.075 was found most suitable. For the 6-in. pipes, thicknesses of 0.050 and 0.060 in. were used, although it is believed the heavier of the two is preferable. Experience revealed that sheets thinner than 0.050 in. were not satisfactory for use in 6-in. pipes and other parts of similar size because of their lack of resistance to warping. The thin sheets, particularly those with a thickness of 0.020 in., were used advantageously for straps to seal the joints in the thicker shapes.

In constructing parts of the model having complex features and not requiring complete transparency, the general form was first built up as a solid by gluing together laminar sections of 0.100-in. celluloid. The exact



THE ELECTRIC OVEN, SHOWING THE ARRANGEMENT OF SHELF, HEATING UNITS, AND THERMOMETERS
The Wooden Molds Are Being Preheated to Avoid Chilling the Celluloid Sheets

features were then carved out of the solid to conform to templates, and the exposed surfaces were painted with acetone to produce a polished surface having a low coefficient of roughness. In making cylindrical shapes, the exact diameter was established after molding the celluloid by measuring the inside or outside circumference with a steel tape or thin strip of celluloid. It is generally difficult to mold segmented circular shapes initially to a true circle, as the celluloid always straightens a little in cooling, but such inaccuracies may be eliminated by measuring and gluing the section to the exact diameter and placing stiffener rings around the cylinder.

If it is necessary to scrape or sand the surface to remove roughness caused by molding or gluing, transparency and smoothness can be restored by brushing with acetone. However, the celluloid must be dry, and there should be no abnormal amount of moisture in the air while this is being done; otherwise the surface will turn white and lose its transparency.

A model constructed of celluloid should be used within a period of six months, and the temperature and humidity should be maintained as nearly constant as possible. After the Fort Peck tunnel model had been in place for approximately 10 months, including 5 months in which no water was in contact with the celluloid, it was observed that considerable shrinkage had occurred, causing distortion of the more irregular shapes.

The hydraulic laboratory of the Missouri River Division is under the supervision of Col. R. C. Moore, division engineer in charge. Special credit for assistance in the preparation of this paper is due D. H. McCoskey, Assoc. M. Am. Soc. C.E., formerly assistant to the writer and now in charge of hydraulic engineering for the Kansas City District Office.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Abbreviation of Engineering Terms

Dear Sir: In a letter to the editor entitled "Diagram for Williams-Hazen Formula Not New," in the April issue of CIVIL ENGINEERING, there is comment regarding abbreviated forms of the term, "cubic feet per second." I beg to point out that in India we use "cusecs," which is not ambiguous and cannot lead to confusion. It would appear to be a suitable abbreviation for universal adoption by English-speaking countries.

Simla, India
July 20, 1936

M. T. GIBLING
Secretary, Central Board of Irrigation

Editor's Note: In the matter of abbreviation of engineering terms, the Society follows the American Tentative Standard, approved by the American Standards Association in November 1932 and sponsored by the American Association for the Advancement of Science, the American Institute of Electrical Engineers, the American Society of Civil Engineers, the Society for the Promotion of Engineering Education, and the American Society of Mechanical Engineers. This standard has been printed in pamphlet form under the title, "American Tentative Standard Abbreviations for Scientific and Engineering Terms."

Malaria in the Irrigated Valleys of New Mexico

TO THE EDITOR: The article on "Malaria—a Challenge to Engineers" by J. A. LePrince, in the July issue, invites comment. Malaria in the irrigated valleys of New Mexico, particularly in those regions where agricultural drainage is necessary, has become a distinct public health problem. A large number of the mosquito-breeding places have been created by lack of forethought on the part of engineers constructing highway and irrigation systems. Many undrainable borrow pits have been excavated to a point below the ground-water level. Eleven counties have been definitely proved to be in the malaria zone. Cases of malaria have been reported during the past year from all counties through which the Rio Grande flows and from some parts of Mora and San Juan counties. In 1927 a few cases of aestivo-autumnal malaria were found. However, subsequent cases have been all benign tertian.

All three of the species of Anopheles known to breed in New Mexico—namely, maculipennis, pseudopunctipennis, and punctipennis—are capable of carrying malaria, but maculipennis is probably the only important carrier. Maculipennis is not found east of the Rio Grande Valley except for a small area in the Mora Valley.

The construction of the open-canal type of agricultural drain furnishes an ideal breeding place for Anopheles, as they thrive in the cool ground water and the abundant aquatic vegetation offers protection. In addition to these agricultural drains, there are many ancient river channels, which are too low to be adequately drained, and miles upon miles of man-made borrow pits that have been excavated to a depth below the ground-water level. A series of these pits is shown in the accompanying photograph. Many of the borrow pits were made for the purpose of securing earth to build large irrigation canals above the normal ground level. Highway construction has also been responsible for many undrained borrow pits.

Another important breeding ground, especially in the northern part of the state, is the so-called "wet meadows." Pasture lands are sometimes irrigated continuously so that the ground is boggy at all times. In other areas water from higher irrigated lands comes to the surface in the form of springs and seeps. Hoof-prints are often several inches in depth, and they hold sufficient water to make ideal breeding places. In addition, such small reservoirs of water are remote from the natural enemies of the mosquito.

Under the direction of Dr. C. W. Gerber, district health officer,

Doña Ana County has had an elaborate mosquito-control program in operation since 1927. This is the largest control program of such a nature in the United States. Approximately 250 miles of agricultural drainage canals, in addition to numerous borrow pits and ponds, are treated at biweekly intervals from February until November. In general, hand dusting with paris green mixed

CROSS-SECTIONING A SERIES OF BORROW PITS PREPARATORY TO FILLING FOR MALARIA CONTROL

with ditch-side soil (usually a sandy adobe) in the ratio of 1:100 and applied at the rate of one pound of paris green to the acre of water surface has been found to be effective in controlling mosquito breeding. This amount of paris green does not poison the water and it may still be used safely for irrigation and for stock-watering. There are some areas where oil, distributed by means of a hand spray, is utilized to advantage.

During the past two years relief labor has been used on malaria-control projects in eleven counties. An average of about 600 men has been employed in eliminating mosquito-breeding areas. All work has been under engineering control and under the supervision of the state bureau of public health.

PAUL S. FOX, Assoc. M. Am. Soc. C.E.
Public Health Engineer,
State Bureau of Public Health

Santa Fe, N.Mex.
August 5, 1936

Comment on Educational Survey of Engineering Profession

DEAR SIR: Your issue of August 1936, under the title "The Education of the Engineer," carries a résumé of the article, "Educational Qualifications in the Engineering Profession," which appeared under the authorship of Andrew Fraser, Jr., in the *Monthly Labor Review*, of the U. S. Department of Labor. It is entirely proper that reviews of this article should have been published in the various professional engineering journals, as it is a very significant contribution to our knowledge of the profession. The results of this survey will be quoted widely, and it is highly important not only that the data be representative of the profession at large, but that the analysis and interpretation of the data be accurate.

For this reason I venture to call attention to the following statement of Mr. Fraser in the above-mentioned article: "Graduate study in engineering does not appear to be of any considerable importance as a prerequisite to practice in the engineering field." This is followed by a summary of proportions of graduates in the principal professional divisions who hold master's degrees. Presumably these ratios are based upon analysis of returns from all groups reporting, regardless of age or length of period since graduation.

For the past two years a comprehensive survey of the status of graduate work in American engineering colleges has been in progress under the joint direction of a committee of the Society for the Promotion of Engineering Education and the U. S. Office of Education. Part of the results of this survey appeared in the S. P. E. E. *Proceedings*, 1935 volume. A final, comprehensive report is now in the hands of the public printer. One purpose of this survey was to learn the trends of graduate work in recent years. The results indicate a very rapid growth during the past fifteen years, as the following tabulation indicates:

ACADEMIC YEARS	TOTAL NUMBER OF STUDENTS ENROLLED IN GRADUATE WORK IN ENGINEERING (U. S. A.)	TOTAL NUMBER OF ADVANCED DEGREES IN ENGINEERING CONFERRED
1921–1922	368	178
1925–1926	1,014	267
1930–1931	2,939	418
1931–1932	3,961*	1,002
1933–1934	2,756*	1,197

* The apparent shrinkage in enrolment from 1931–1932 to 1933–1934 is due to the fact that up to and including 1931–1932, when the statistics were compiled by the Office of Education, all graduate students enrolled in engineering colleges, schools, and departments were counted, including some students of non-engineering courses. Thus the figures were somewhat inflated prior to 1933–1934. For that year, however, the figures are accurate. All American engineering institutions offering graduate courses are included.

The tabulation indicates a very rapid growth in graduate study: In enrolments there was a gain of nearly eight-fold between 1921–1922 and 1933–1934; while in number of graduates of advanced courses the gain was nearly seven-fold in the same period. At the present time the number of graduate students of engineering is roughly one-fourth the number of bachelor's degrees conferred during the preceding year, and the number of master's and doctor's degrees conferred in any year is roughly one-eighth the number of bachelor's degrees conferred in that year.

It seems proper, therefore, to question the inference that graduate work in engineering is of relatively little importance as a prerequisite to practice. The fault in this interpretation appears to lie in the fact that the analysis was based upon the entire group of engineers canvassed, regardless of age. Such an analysis would assume the conditions in the engineering profession as to education and training to be static. It is clear that conditions are changing and that there has been a strong trend toward graduate work in engineering education in recent years; it is also clear that industry and the profession at large are beginning to look upon graduate work as a highly desirable preparation for certain fields of work.

It may be hoped that the Labor Department can amplify its results in terms of studies of the several age groups among those who supplied information.

H. P. HAMMOND, M. Am. Soc. C.E.
Chairman, Committee on Graduate Study, Society for the Promotion of Engineering Education

Brooklyn, N.Y.
August 12, 1936

Corrections in Excavation Quantities for Oil Camp Transportation Work

DEAR SIR: In my article, "Transportation for a Wildcat Oil Camp," which appeared in the August 1936 issue, a maximum figure of 8,400 cu yd of excavation per mile is given on page 503 for railroad grading, and on page 504, a figure of 4,200 cu yd per mile for highway work. I believe that the original figure for the highway work was 20,000 cu m per km. Converting this to cubic yards per mile by using the factors,

1 mile = 1.609 km
1 cu yd = 0.76 cu m

the correct amount is approximately 42,000 cu yd per mile. Similarly, the figure for track grading should be 16,900 cu yd per mile.

ROBERT STEPHENSON, Assoc. M. Am. Soc. C.E.

New York, N.Y.
August 12, 1936

Further Comments on Computation of Influence Lines

TO THE EDITOR: I am writing in regard to Lewis K. Oesterling's discussion, in the May issue, of my article on influence lines, which appeared in the December 1935 issue of CIVIL ENGINEERING. In his discussion Mr. Oesterling makes use of moment distribution.

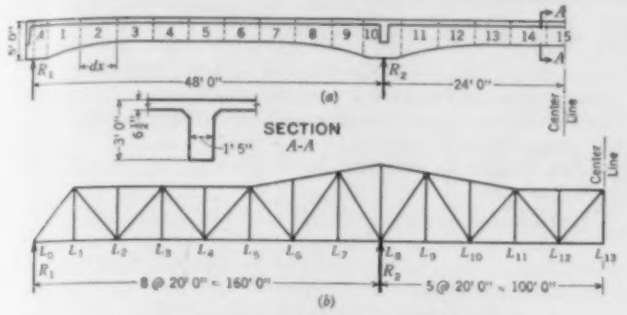


FIG. 1. TYPICAL CONTINUOUS BRIDGES
Both Are Symmetrical About the Center Line

In order to do this it is necessary to determine the fixed-end moments in the two spans adjacent to the applied unit deflection. For all spans it will be necessary to know the stiffness and carry-over factors. The calculation of these quantities for beams of varying moment of inertia would take considerable time unless suitable tables or curves are available.

In Fig. 1 are shown two types of continuous bridges that have been designed by the bridge department of the Kansas State Highway Commission, using the method described in my article. For the analysis of the span shown in Fig. 1 (*a*), the deflections of the simple beam R_1R_4 were calculated by dividing the beam into short sections and using the method of moment areas. For this case the areas under the M/EI curve were used. The final results as calculated by this method checked very closely a preliminary graphical analysis by the fixed point method together with Strassner's tables, "Neurer Methoden." Strassner's tables may be used to advantage in the moment distribution for this type of beam.

For the case of the continuous truss, Fig. 1 (*b*), I do not believe that moment distribution would simplify the problem. The simple truss deflections of the truss R_1R_4 were calculated by "elastic weights" and the Williot-Mohr diagram.

Mr. Oesterling mentions that the effect of distant spans is small. That is true, but for most of our continuous bridges there have seldom been more than five spans, and it has been our practice to carry the analysis over all spans for purposes of check. Mr. Oesterling's discussion is a valuable addition to the subject of influence lines and will be very useful to those familiar with moment distribution.

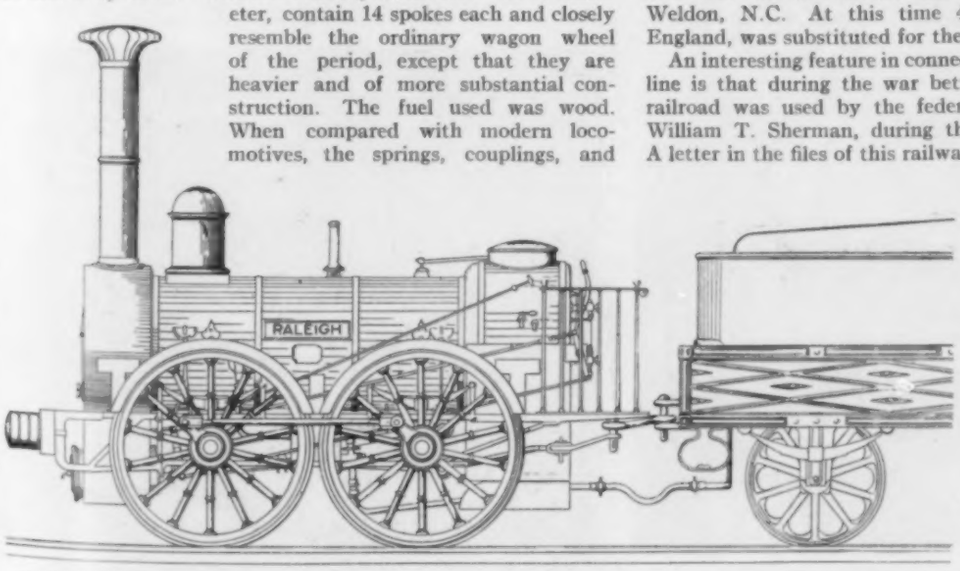
V. L. PIERCE
Bridge Designer,
Kansas State Highway Commission

Topeka, Kans.
August 5, 1936

Notes on an Early Locomotive

TO THE EDITOR: I have been interested in the reproductions of early locomotives that have appeared in past issues of CIVIL ENGINEERING and would like to comment briefly on the *Raleigh*, which is shown in the accompanying illustration. The *Raleigh* was the first locomotive used by the Raleigh and Gaston Railroad Company on its 84-mile line from Raleigh, N.C., to Gaston, N.C. The Raleigh and Gaston Railroad, built between 1836 and 1840, was one of the first railroads in the United States. It is now part of the Seaboard Air Line Railway system, operating 5,816 miles of track.

The *Raleigh* is one of the earliest and most primitive types of locomotives used on a railroad in this country. The two cylinders are each 12 by 16 in. The four drivers, which are 54 in. in diameter, contain 14 spokes each and closely resemble the ordinary wagon wheel of the period, except that they are heavier and of more substantial construction. The fuel used was wood. When compared with modern locomotives, the springs, couplings, and other parts of this locomotive appear quite crude. The absence of the pilot and engine truck wheels is significant, although the pilot appears to have been provided for to some extent by a spring buffer at the front of the locomotive. Since the *Raleigh* was not provided with a cab, the operator evidently performed his duties without protection from the weather.



THE "RALEIGH," THE FIRST LOCOMOTIVE ON THE RALEIGH AND GASTON RAILROAD
Built at Warrington, England, in 1836

The Raleigh and Gaston Railroad Company was incorporated by special act of the legislature of North Carolina, December 21, 1835, the principal office of the company being located at Raleigh, N.C. Construction of the line was commenced November 1, 1836, at Gaston, N.C., and was completed to Raleigh, a distance of 84 miles southward, on May 10, 1840. The road was originally constructed standard gage, 4 ft 8½ in., with longitudinal wood stringers, capped with flat iron. During the period from 1851 to 1853 the line was rebuilt and extended 12 miles northward to Weldon, N.C. At this time 45-lb iron rail, manufactured in England, was substituted for the wooden stringers.

An interesting feature in connection with the Raleigh and Gaston line is that during the war between the states (1861–1864) the railroad was used by the federal forces, under Major-General William T. Sherman, during their occupancy of that territory. A letter in the files of this railway, dated Raleigh, April 20, 1865, from General Sherman to Dr. J. W. Hawkins, then president of the Raleigh and Gaston Railroad, stated that he had no objection to the restoration of the railroad to its owners, but for a few days would like to borrow or rent some locomotives and cars. Since the locomotive *Raleigh* was used in the service up through the year 1869, it is evident that it played a part in the military activities of that period.

W. D. FAUCETTE,
M. Am. Soc. C.E.
Chief Engineer, Seaboard Air Line Railway

Norfolk, Va.
July 22, 1936

SOCIETY AFFAIRS

Official and Semi-Official

More About the Fall Meeting

Pittsburgh Sessions, October 13–16, Are Complete and Attractive

BRIEF ANNOUNCEMENT of general plans for the coming Fall Meeting in Pittsburgh were given in the August number. The active cooperation between the Pittsburgh, Cleveland, and Central Ohio Sections and the different Technical Divisions has brought about an extensive program. To accommodate the heavy schedule, the meeting will open, contrary to the usual practice, on Tuesday instead of Wednesday. The opening day will be devoted to two general meetings, Wednesday and Thursday to Technical Division symposiums, Friday being reserved for excursions.

The technical program is built up as a number of symposiums devoted to timely subjects. Every symposium is carefully prepared and arranged to give the maximum benefit to the engineers who will have the opportunity to attend the meeting.

FLOOD CONTROL FROM MANY ANGLES

The recent floods in the eastern part of the United States have made the problem of flood control one of the outstanding present engineering problems. In view of Pittsburgh's long history and recent experiences it is quite appropriate that the general meeting on Tuesday should be devoted to the basic problem of flood control.

Following the customary addresses of welcome on Tuesday morning, October 13, there will be a semi-technical address, which with the afternoon program will include the following topics:

"Flood Disaster of 1936 in Eastern United States"
"Health and Sanitation Aspects of the 1936 Floods"
"Economic Aspects of Flood Control"

The topics will be further developed on Wednesday in papers on

"The New England Flood"
"The New York Flood"
"The Upper Ohio and Tributaries Flood"
"Federal Plans for Flood Control"

This symposium will provide the engineering data necessary to determine along what lines flood-prevention activity should be directed in order to be most effective and economical.

ECONOMIC ASPECTS OF ENERGY GENERATION

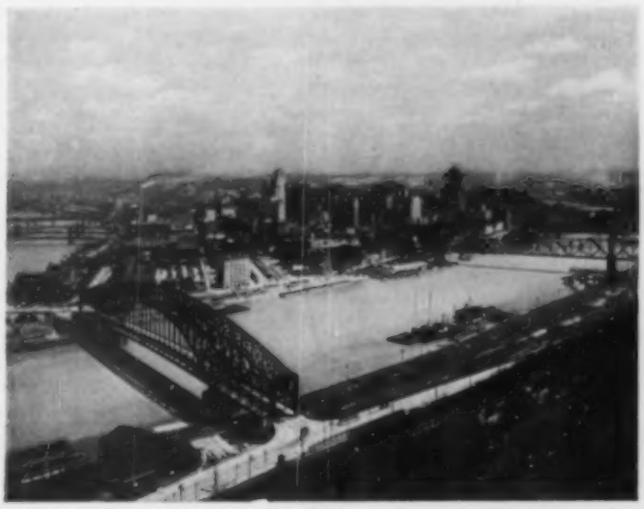
Realizing that at present the energy generation problem goes far beyond considerations of engineering economics, the Power Division and the Engineering-Economics and Finance Division have joined forces and arranged a symposium in which engineers supply the introductory papers dealing with the engineering aspects, and the closing paper is supplied by two noted economists. This symposium, also to be presented on Wednesday, is composed of the following papers:

"Thermo-generation of Energy"
"Hydro-generation of Energy"
"Improvements in Utilization of Energy"
"Cost of Generation of Energy"
"Economic Aspects of Energy Generation"

STRUCTURAL APPLICATION OF STEEL AND LIGHT-WEIGHT ALLOYS

Officers of the Structural Division and its committees have developed comprehensive plans for a four-session symposium occupying Wednesday and Thursday, devoted to progress in methods of design and special materials. It is particularly fitting that in Pittsburgh, a center of steel and alloy manufacture, these sessions should comprise a presentation of the manufacture and applications of those steel and light-weight alloys which affect or promise to affect the field of structural engineering. The unification of this symposium on "Structural Application of Steel and Light-Weight Alloys" has been a considerable task, comprising an agreement upon the outline, the selection of appropriate authors for a dozen or more papers, the criticism and coordination of their synopses, and the editing of the completed papers. As a result, the symposium will constitute an unusually valuable and unified whole, with papers on the following subjects:

"Modern Stress Theories"
"Tests of Engineering Structures and Models Thereof"
"Photoelastic Determination of Stress"
"Metallurgical and Manufacturing Aspects of Structural Ferrous Alloys"
Part 1: *"Low Alloy Steels"*
Part 2: *"High Alloy Steels"*
"Metallurgical and Manufacturing Aspects of Light-Weight Structural Alloys"
"Corrosion in Relation to Structures and Structural Materials"



PITTSBURGH'S "GOLDEN TRIANGLE" WHERE THE ALLEGHENY AND MONONGAHELA RIVERS MEET
Historic Spot, Where Society's Fall Meeting Will Convene

Photo by V. L. Hubbard, Pittsburgh

EDUCATIONAL, ART AND RESEARCH FACILITIES CENTER AROUND UNIVERSITY OF PITTSBURGH'S 42-STORY CATHEDRAL OF LEARNING

"Actual Applications of Special Structural Steels"

"The Field of High-Strength Steels in Structural Engineering"

"Application of Stainless Steel in Light-Weight Construction"

"Structural Application of Aluminum Alloys"

"Magnesium Alloys and Their Structural Application"

It is hoped that the papers will be published in PROCEEDINGS in time to provide opportunity for prepared and interesting discussion at the Meeting.

PROBLEMS IN PLANNING MAJOR HIGHWAYS

The two sessions of the City Planning Division will be held Thursday, with subjects of great importance in connection with the city planning problems of the Pittsburgh district. The first relates directly to the volume of traffic handled by the street system. The transition from an old city with narrow streets to a modern street system, capable of handling a large volume of traffic, has been under way for about fifteen years. The first group of papers therefore includes:

"Factors Controlling Traffic Capacities in Existing Street Systems in Congested Districts"

"Methods of Relieving Congestion and Increasing Capacity on Existing Street Systems"

Because of the limitations of topography, the widening and improvement of highways to take care of modern traffic requirements has been very expensive. Various phases of this problem will be treated under the subjects:

"The Effect of a Major Highway on the District It Traverses"

"Effects of Alignment, Grade, and Width on Direct and Indirect Costs of Major Highways"

"Relation of Highway Costs to Taxable Values and Community Wealth"

While all the papers will discuss the situation existing in Allegheny County, it is believed that the facts brought out will be of general interest to all parts of the nation.

STREAM POLLUTION

In harmony with a recent tendency toward appraisal of all aspects of conservation and proper utilization of water resources, the Cleveland Section, cooperating with the Sanitary Engineering Division, has developed a symposium on stream pollution in the Ohio River valley. This will concern itself with past progress in sanitation in that important watershed, critical problems now existing, the outlook for coordinated planning of needed works, and the possibility of securing their enablement. The long experience of existing agencies for planning will be reviewed. Emphasis will be on the adequacy of engineering organizations in initiating needed projects and in properly relating them to area needs, as distinct from their competence in technical matters in the realm of design or treatment.

The program developing these ideas covers the following topics:

"What Can We Do About Stream Pollution?"

"Progress in Stream Pollution Control in the Ohio River Basin"

"Stream Pollution Problems at Cincinnati, Ohio"

"Planning for Pollution Control at Pittsburgh"

"The Pymatuning Reservoir as a Factor in Regulating Stream Flow for Dilution Purposes"

"Sanitation Problems Incidental to Floods in Pennsylvania"

"Some Engineering Aspects of Stream Pollution Control"

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MODERN HIGHWAY DESIGN AND CONSTRUCTION

The two sessions of the Highway Division are being sponsored by the Central Ohio Section and will occupy all day Thursday. In selecting the papers, an attempt was made to get as much of a cross-section of highway problems as possible. Design is covered by two papers; highway structures, soil mechanics, weathering of asphalts, and concrete durability by one paper each, as shown by the following subjects:

"Important Considerations in Modern Highway Design"

"Application of Soil Mechanics in Highway Construction"

"The Development of Highway Bridges in Ohio"

"Weathering of Asphalts"

"Concrete Durability"

"Design of Rigid-Type Pavements"

THE STATE SYSTEM OF PLANE COORDINATES

For its session, the Surveying and Mapping Division has planned a half-day program. This is to be held on Wednesday afternoon, and will deal with the following:

"The Use and Advantages of the State System of Plane Coordinates"

"Commercial Application of Coordinates Surveys"

SOCIAL EVENTS BEING ARRANGED

From the foregoing outline of the technical program for the Fall Meeting, it is evident that such a wealth of engineering information will be presented that a very large attendance is assured. The speakers are men of note in engineering, political, and economic circles, who will bring up-to-date and authoritative messages on their special subjects. But the meeting will also include most attractive social features which will likewise offer a variety of interest for members and ladies.

One of the high spots of the art life of the world is the yearly art exhibition arranged by the Carnegie Institute. Paintings are brought to Pittsburgh from all countries of the world, and the exhibition and the results of the award of prizes by world-known juries are landmarks in the development of art. Before opening the International Exhibition to the public, the Board of Trustees of the Institute is holding a preview by issuing personal invitations. The previews have become the most important event in Pittsburgh's social life. On Wednesday evening, October 14, this year's preview will be held and the Board of Trustees is extending a personal invitation to all members, their ladies, and guests who will attend the Pittsburgh Meeting. Thus a unique opportunity will be offered to view this world-renowned art exhibition and to get in touch with Pittsburgh social circles. Local artists will act as guides to our members who would like to get more intimate glimpses of the exhibit. A social after-party is planned for members and ladies.

Tentative plans for entertaining visitors call for a smoker on Tuesday night, October 13, for the men, with possibly a theater party for the ladies. Thursday night is being reserved for a dinner dance, and Friday all day will be given over entirely to the excursions. While plans are not final, tentative arrangements contemplate an excursion to the Homestead Plant of the Carnegie Illinois Steel Company and to the plant of the Aluminum Company of America at New Kensington. Plans will later be made for sightseeing and other trips to points of interest.

In addition to the social features enumerated, the Ladies' Entertainment Committee expects to entertain visiting ladies at teas, bridge parties, and similar functions during the week. Opportunity will also be available to play golf, for members who do not desire to spend the whole time in technical sessions.

Complete details of the Fall Meeting will appear in the October number of CIVIL ENGINEERING. Meanwhile preparations are going forward to perfect the valuable engineering program and the social arrangements that will leave nothing to be desired. The hints here given as to the general outline should suffice to ensure the definite attendance of every engineer within reach of the Pittsburgh Fall Meeting, irrespective of whether he is or is not a member of the Society.

Problems of the Committee on Student Chapters

Some Practical Questions Encountered in Furthering Its Ambitious Program

By HUNTER W. HANLY, M. AM. SOC. C.E.

CHAIRMAN, COMMITTEE ON STUDENT CHAPTERS; STRUCTURAL ENGINEER, CINCINNATI, OHIO

THE Committee on Student Chapters is charged with the task of recommending and putting into effect approved "methods and procedures calculated to be of value to the students in civil engineering." Having in mind the objects of the Society as stated in the Constitution—"the professional improvement of its members, the encouragement of intercourse between men of practical science"—and further, recognizing the position and function of faculty and curriculum in the engineer's career, the course of the Committee is rather clearly defined. Reaching its objective is the problem.

Students in college can rarely be expected to be profession-conscious, to have more than a very abstract conception of "ethics of the profession," or to have a sense of belonging to a society. Certainly this is true at least until they have had close and extensive contact with the members and the atmosphere of that profession and that society.

Increasing interest on the part of engineers' clubs and other organizations in vocational counseling, but more especially the work of the Engineers' Council for Professional Development, will ultimately serve to give the entering student a clearer conception of his future. Up to now—and it will probably continue during the near future—many students reach their commencement day with a very limited comprehension of their chosen career beyond its scientific basis. For it is usually beyond the limits of available time and facilities for the faculty to go into this phase of a career. In fact, many have voiced the extensive and growing attitude of engineering educators that the college is for educating students to become engineers, not for training engineers. So it appears that the experience of actual contact with engineering as a career must generally come from without the school. This experience, which, in the field of medicine makes the period of interneship for medical students so valuable, the Society offers by its interest in Student Chapters as part compensation for the lack of equivalent opportunities among civil engineering students.

THE OBJECTIVES OF THE COMMITTEE

To bring to Student Chapters the facilities of the Society and assist the students to extend their acquaintance with the practice of engineering and with practicing engineers;

To bring local and regional Society groups to an appreciation of the reservoir of talent and inspiration which they constitute for the student engineer, and to enlist their active support of Student Chapter enterprises in their vicinity in cooperation with contact members and faculty advisers; and

To develop a more extensive establishment of state or regional conferences of Student Chapters, more effectively programmed and conducted in furtherance of the objects of the Society.

CONTACT MEMBERS FILL IMPORTANT RÔLE

As a first step in extending such opportunities, it is provided that each Student Chapter shall have a contact member, a member of the Society from outside the school, whose standing as an engineer and conduct as a member of the Society shall merit the esteem of the students, and inspire them to think in terms of the Society. These contact members are expected to visit their Chapters frequently and to work in harmony and cooperation with faculty advisers and Chapter officers, in finding worth while outside talent as program material.

The current activity among Local Sections directed towards organizing all members of the Society not now included, into local or state sections, is a move that will also assist the Committee on Student Chapters. Our Committee expects in the immediate future to devote attention to making all Local Sections acquainted with their opportunities along this line, and to invite them to support contact members with their resources. Similar assistance of Sections is also needed in enlisting representative and interested engineers from whom contact members may be selected.

Local Sections might extend their hospitality to Student Chapters within a convenient driving distance, and make their influence even greater through occasional well-planned programs, of which student papers or discussions are features. Such meetings have not always been well set up. On one occasion, at least, a special joint meeting between a Local Section and its neighboring Student Chapter had only one student in attendance; there was not a Chapter officer, faculty adviser, or contact member among those present. Examinations and other conflicting student affairs had been overlooked in the planning.

The establishment of regional conferences of Student Chapters within short distances of one another is occupying the Committee. This has developed greater interest in the student element of the Society, and bids fair to change the student's conception of the possibilities of his organization. The Committee is at present engaged with Society Headquarters in making the student conference sessions of the four quarterly meetings of the Society a feature of interest and importance that will appeal both to the student and to the mature engineer.

ANNUAL REPORT MAY GIVE INADEQUATE PICTURE

Student Chapters have great latitude in the matter of programs and activities. Almost no restriction is placed upon them by the Society other than that Chapters and faculty advisers shall submit annual reports giving statistical and descriptive matter covering the year's activities. Sometimes these reports are obviously the work of good press agents; sometimes they are modest diaries of what may have been really an excellent year's work. Rarely do they tell in excellent fashion of the fine things, so well done; all too frequently they leave the impression that the Chapter is not thinking of its function and possibilities in the light of the future, but rather in terms of the usual run of sports and fraternal and social activities. Sometimes, indeed, they are so brief as to convey little impression of any activity at all. And yet these annual reports are the sole source of information upon which to judge the Chapter's condition and the merits of its work. While the President's official Letters of Commendation for Merit have been awarded to really noteworthy chapters, it is possible that some excellent Chapters have suffered through lack of a good reporter.

Perhaps the most effective step taken by the Society in behalf of the Student Chapters was the appointment of a Field Secretary. His personal contacts with Chapters and faculty, bringing about as they do an understanding and a sense of intimacy between all elements that would have been impossible of attainment through the Committee's activities alone, will have lasting results.

The work of the Committee on Student Chapters is one of remote control. It is accomplished largely by suggestion, through the mails, with scant knowledge of the attending limitations or possibilities for these suggestions being adopted. The Committee solicits therefore, from Chapters, faculty advisers, and interested outside members, constructive criticism of all phases of its work.

Continuing Student Chapter Conferences

THE SERIES of Student Chapter conferences for the academic year 1936–1937 will be opened with a conference to be held in Pittsburgh, Pa., at the time of the Fall Meeting of the Society. The Committee on Student Chapters is at work on a program that gives every evidence of being interesting, stimulating, and worth while.

The conference has been scheduled for 2 p.m. on Thursday, October 15. This will give visiting students an opportunity to attend Technical Division sessions on Thursday morning and, if they care to, stay over to join the inspection trip on Friday. Of course, if they can attend the Technical Division sessions on Wednesday or the general sessions on Tuesday, they will be most

welcome. Every facility of the quarterly meeting—technical, professional, and social—will be open to them on the same basis as to members of the Society.

With the reinstatement of the Student Chapter at Mississippi State College in July, the number of Student Chapters has been increased to 114. Through the annual reports of the Chapters, through the visits of Field Secretary Jessup and other officers of the Society, and from the results of the 1935–1936 series of Student Chapter conferences, it is evident that Chapter affairs are in a flourishing and highly encouraging state. There is greater activity, programs are of a higher quality, and applications for Junior membership are pouring in at a rate never before equaled. Elsewhere in this issue are shown the current statistics on applications, including the influence of Junior applications this summer, and also reports from practically all the Chapters.

Those who follow Student Chapter matters are keenly aware that our Chapters are not standing still. As the principal reservoir of future members of the Society, their aspirations, activities, and needs merit the interest of all members of the Society.

Results of First Ballot for Official Nominees

New York, N.Y.
August 1, 1936

To the Secretary
American Society of Civil Engineers:

The tellers appointed to canvass the First Ballot for Official Nominees report as follows:

Total number of ballots received	1,612
Deduct:	
Ballots from members in arrears of dues	139
Ballots without signature	6
Total withheld from canvass	145
Ballots canvassed	1,467

For Vice-President, Zone II

J. Houstoun Johnston	139
L. F. Bellinger	129
A. C. Polk	81
Scattering	41
Blank	17
Total	407

For Vice-President, Zone III

R. C. Gowdy	158
D. J. Brumley	141
Charles H. Paul	119
Scattering	69
Total	487

For Directors, District 1 (two to be elected)

William J. Shea	237
Enoch R. Needles	231
R. E. Bakenhus	103
Ineligible Candidates	107
Scattering Nominations	52
Ballots with one space blank	48
Total votes cast in District 1	778
Actual number of ballots received from District 1 (One half of above figure)	389

For Director, District 2

Arthur W. Dean	64
Ineligible	18
Scattering	19
Total	101

For Director, District 6

R. P. Davis	58
Scattering	6
Blank	3
Total	67

For Director, District 10

N. W. Dougherty	49
T. Keith Legaré	41
F. J. Lewis	35
Scattering	17
Void	1
Blank	15
Total	158

For Director, District 13

Thomas E. Stanton, Jr.	97
George W. Hawley	10
Ineligible	26
Scattering	22
Total	155

Respectfully submitted,

V. T. BOUGHTON, *Chairman*

A. H. Baker	Hans R. Jacobsen
B. F. Biemann	John J. Nanry
Charles W. Comstock	Irving B. Thorner
Robert Stephenson	George M. Purver
Henry Manley	Philip M. Parker
Theodore Grahlman	James McB. Webster

Tellers

Emphasizing Student Interests

SHORTLY most of the engineering schools in the country will be reopening. It is therefore fitting that the current issue of CIVIL ENGINEERING should contain an unusual number of matters of special interest to members of Student Chapters. One of the main papers is from the pen of a Student Chapter member; another from a teacher who has made a life-long study of engineering education; and a third from a member of the Corps of Engineers of the Army, whose praise of the profession should be an inspiration to every beginner.

Then a number of items of similar interest have been included in the news sections, such as a prize-winning paper in a junior competition, another considered to be one of the best at a Student Chapter regional meeting, and advice to students from a Past-President of the Society.

In order that these features may serve their purpose to the fullest extent, the Committee on Publications has determined that each member of every Society Student Chapter shall receive a complimentary copy of this issue. It is expected that this demonstration of interest in the welfare of the students will result in disclosing a reciprocal feeling of goodwill toward the Society. Examination of the excerpts from the annual reports of about 100 Student Chapters, also included in this issue, will indicate the valuable work being done in American colleges to inculcate Society and professional ideals in prospective engineers.

Publication Progress Reported

ADVANCEMENT, even in minor respects, is always gratifying. It is a pleasure therefore to record definite progress in the publication of CIVIL ENGINEERING as illustrated by two features in particular. Because of the distribution of the current number to all members of Student Chapters, the edition will total about 20,000 copies. This is the largest to date and it is hoped that the extent of distribution will be a measure of the total benefits accruing to readers.

Interest in CIVIL ENGINEERING on the part of advertisers is also gratifying. The quantity of paid advertising contained in the August number was the largest since the inception of the publication in 1930.

In these indications of approval, authors as well as readers may take a considerable measure of satisfaction.

Student Chapters Need the Help of Local Sections

Society Groups Should Take an Active Interest in Nearby College Organizations

BY ARTHUR S. TUTTLE, PAST-PRESIDENT AM. SOC. C.E.
CONSULTING ENGINEER, AND NEW YORK STATE DIRECTOR, PWA, NEW YORK, N.Y.

This month, 114 Student Chapters—the "door to the Society" for hundreds of young engineers—will begin another season of activity. Before the schools open, officers of Local Sections, contact members, and faculty advisers might well give thought to how they may best serve the interests of these important groups. Past-President Tuttle's address before the spring conference of Student Chapter representatives at Hot Springs, Ark., abstracted here, contains some arresting thoughts on the subject. The problems of the students themselves were brought out in a brief account of this conference, published in August.

As I look back over the existence of the Society, I note two important epochs. The first was in 1905, fifty-three years after the Society was founded, when the first recommendation was made about a Local Section. Before that, growth had been very slow. After the Local Sections began to be formed it was found that there had been created something which represented the Society appealingly and directly to its membership. The other epoch was in 1920 when the first recommendation was made about Student Chapters. Before that date the grade of Junior in the Society did not appeal very strongly to our young men. I noted in the New York meetings that a young man felt himself completely eclipsed. He had no chance to express himself and he wasn't given much encouragement to do so. The beginning of the Student Chapters was for these young men the opening of a door to the Society, arousing their interest before they actually became Juniors. Until then Junior membership had been shrinking steadily for many years, going from nearly 1,000 down to about 450 at the time the first Student Chapter was recognized. From then on there has been a growth that spells prosperity because it means the bringing in of young blood. Today we have something more than 3,000 Juniors that have come out of this reservoir of Student Chapters in recent years. Many men who were Juniors at one time have transferred to a higher grade.

Meanwhile our Student Chapter membership has grown by leaps and bounds. During the last three or four years it has reflected somewhat the depression we have been going through, but not so much as we expected. Chapter membership is rising again, and the number of Chapter members coming into the Society as Juniors following their graduation is greater than it ever was before.

You have asked me what the Local Sections can do for the Student Chapters. It is a singular thing that the activities growing out of the two epochs previously mentioned have not been better coordinated. The Constitution and By-Laws do not reveal anything of the obligation that a Section should feel toward the Student Chapters in its neighborhood. I am happy to say that many of the Sections have assumed these obligations of their own accord. They should do so for many reasons, only one of which is that the Chapters are the reservoir from which most of our membership comes. Some of the Section officers help the Chapter officers to find a speaker or two but I think that in many cases the contact ends right there.

I come from New York. Within a 50-mile radius there are eight Student Chapters, each independently active and each enthusiastically a member of the Metropolitan Conference of Student Chapters. Yet I doubt if our Section members know very much about what these Chapters are doing. Interest is increasing however. The Section has a Committee on Student Chapters made up of the contact members of these eight units on which there has been recently appointed a Junior who is already making himself useful.

I believe it is wrong to let such matters drift without some kind of direction. We should take some positive steps to see that the Local Sections do take an interest in their Student Chapters. This can be done in many ways, depending on the local situation. A year ago I attended one of the Metropolitan Conference meetings at which student papers were presented in competition for a prize. The papers were surprisingly interesting of themselves and their presentation was amazingly good. I think that any Local Section could well afford to turn over to the Student Chapters the conduct of one of its regular meetings during the year. Let the students run it and I predict that it will not only open the eyes of the older men but create a wonderful amount of enthusiasm in the Chapters.

In many cases I think it would be practicable for the Sections to invite students to their meetings. This will undoubtedly raise problems because Section meetings sometimes "run into money," but where the Section can afford it I think it would give inspiration to many students if they could attend a few good Section meetings.

It has been intimated that some of the contact members are not working as they should. If I recall the system correctly, the contact member appears to keep his job in perpetuity. I think it is clear that something should be done when he is not doing his job. Frequently contact members are busy men, and there are good reasons why some of them cannot do all the students would like them to do. Nevertheless it should be easy to make a change where it seems desirable, and I believe it can be done without embarrassment to any one. There are good men available who have the time to go to student meetings and who will not find it irksome. Student Chapters should turn to a nearby Local Section for help in this.

What of the relation between the Student Chapter and the school? As I have visited Chapters and studied their work, and as I have read the reports of the Committee on Student Chapters, it has become clear to me that the students appreciate Chapter work as part of an engineering education. I doubt if any student expects to spend all of his life in the field of technique alone. The things he can learn by taking advantage of the opportunities available through a Chapter are therefore a very important part of his complete engineering education. Many students of an earlier day failed to get that help.

My contention is that the work of the Student Chapter should be regarded as a definite part of the work of the college, at least to the extent that every enrolled student should be registered as a member of the Student Chapter in his branch of the profession. The university itself should feel some obligation to the Chapters because the Chapters are furnishing something that the university does not offer in any other way. I proposed such a plan last year and nothing has since happened that would lead me to change my mind. On the other hand, that opinion was strengthened by something said earlier today about the difficulties that some students have in preparing exhibits for engineers' day, for which they have to find time on the outside. It seems to me that if a man wants to get busy and help prepare such an exhibit he ought to have all the support of the faculty that he can get. Attendance at meetings and participation in them should also be considered as a very important part of his education.

Freeman Scholar Sails for Europe

LATE in August John Hedberg, Jun. Am. Soc. C.E., sailed for Europe to take up his studies as the Society's Freeman Scholarship appointee for 1936. During his year abroad, Dr. Hedberg will have an opportunity to visit the leading foreign hydraulic laboratories, take courses at one or more universities, and make a detailed inspection of a number of outstanding river improvement projects.

Dr. Hedberg was graduated from Cornell University in 1929. In the following two years he was successively research assistant in hydraulics and instructor in civil engineering at Purdue University, and in 1931 he received his master's degree from that institution. He then went to Stanford University as instructor in civil engineering, and was awarded the doctorate in 1934.

After a year as junior engineer in the canal division of the Bureau of Reclamation at Denver, Colo., he returned to Stanford as assistant professor of civil engineering. A leave of absence enables him to take advantage of the Freeman award.

Dr Hedberg is the tenth to receive the scholarship from the Society since the fund that makes it possible was set up by the late John R. Freeman, Past-President and Hon. M. Am. Soc. C.E., in 1924. The recipient of last year's award, Lieut. Paul W. Thompson, is still in Europe, completing a series of experiments at the Technische Hochschule, Berlin.

Early Presidents of the Society

This is the sixth of a series of historical sketches—biographies of famous pioneers of American engineering. George Sears Greene, Ellis Sylvester Chesbrough, and William Milnor Roberts will be the subjects of the articles appearing during the remainder of the year. The assistance of readers in supplying interesting stories of these men will be heartily welcomed.

VI. JULIUS WALKER ADAMS, 1812–1899

President of the Society, 1873–1875

EVERY SCHOOL BOY can name at least three members of the Adams family who played stellar rôles in the political development of the United States. Possibly a few of the deeper students will recall that a fourth served as a Union Colonel in the Civil War, though it is likely that their acquaintance with his career stops there. Yet that military interlude was but a minor chapter in the life of Julius Walker Adams, and his long years of service in the physical development of his country entitle him to a prominence that political historians have been unwilling to ascribe.

JULIUS WALKER ADAMS
Sixth President of the Society

As a young man, Adams decided upon an army career, and entered West Point in the early 1830's. But about that time, the great "wave of internal improvement" began to sweep the country, and Adams and a number of his classmates soon left the academy for civilian life and cast their lots with the railroad pioneers. Under his uncle, Maj. William Whistler, Adams received his training on the New England roads, and in 1845 became superintending engineer of the Erie, a position he retained for five years.

As the number of engineering works increased, the need for a "clearing house" for technical information became increasingly apparent. In 1850 there were still but few American engineering texts, and no publications in which engineers could discuss theory or exchange practical suggestions. Each had largely to depend upon his own experience, and where that was lacking, upon his own intuition. One of the first attempts to meet this need was Appletons' *Mechanics' Magazine and Engineers' Journal*, which appeared in January 1851. Its publishers found in Adams the combination of engineering and literary skill they were seeking and selected him as editor.

The magazine covered a wide field, and must have exerted a considerable influence in its short life of three years. It published each month complete descriptions of newly patented machines, progress reports on current construction activities, announcements of proposed work, original scientific papers, and abstracts from foreign technical publications. In addition there was a "question and answer" department, in which queries "on any branch of mechanical science or art" received attention.

Adams approached his task with the modesty befitting an editor. "While our best efforts shall not be wanting to lay before our readers whatever of valuable may be gathered," he wrote, "we shall consider ourselves and our labors but as the cement which binds the stones of an edifice together—however good it may be of itself, no man builds a house of it."

During his editorship he also prepared an American edition of *Templeton's Engineer, Millwright, and Mechanic's Pocket Companion*, adding considerable original material to that English work and making of it the first practical handbook actually adapted to American practice.

Shortly after he helped to organize the Society, in 1852, Adams left New York to become chief engineer of the Lexington and Danville Railroad Company in Kentucky. He soon was given a similar position with the Memphis and Ohio, and the Memphis, Clarksville, and Louisville railroads, and was instrumental in bringing about their consolidation. These lines, now incorporated in the Southern Railway System and the Louisville and Nashville Railroad, linked the Northeast with the Southwest and constituted "a main trunk road from the head of certain navigation on the Mississippi [Memphis] to Cincinnati," reducing the time of travel between those points from more than a week to less than a day.

It is interesting to note that Adams was chief engineer of these three roads at the same time. When he went to the Lexington and Danville, he specified that he was to be permitted to avail himself of any other professional employment that might offer. This, he wrote, was "in accordance with universal custom.... Few engineers of any standing confine themselves to the construction of one work if their services are in demand elsewhere." He added that the chief engineer's duties did not require daily attention to the work, and that the company looked to him only for the result.

In the 1850's, municipal water supply and sewage disposal projects increased rapidly in number and importance. Turning to this field in 1857, Adams designed the sewerage for Brooklyn—the first system in this country in which sewer sizes were not selected by rule-of-thumb methods, and in which the time of concentration was taken into account in computing capacities. On the basis of this work he later wrote the first comprehensive treatise on the sewering of towns issued in America, *Sewers and Drains in Populous Districts*. This work was still a standard text in the early years of the present century, and passed through several editions. The preface gives a clear picture of the status of the art when he took up his work in Brooklyn:

"In 1857 we were totally without data of any kind in this country to guide in the determination of the proper dimensions of sewers. No gagings had ever been made" of their discharge, and "the only principle recognized was to make the sewers large enough to admit of the entrance of workmen to clean them by the use of the pick and shovel; so little had the subject occupied the attention of engineers that it was scarcely thought within their province . . . to do more than to see to the proper construction of what was determined upon by property owners, city surveyors, and municipal councils."

By applying hydraulic principles, including the theory of concentration time that had been enunciated by Neville, Adams was able to reduce the size of sewers and their cost, and his installation proved to be so successful that twenty years later he was able to state that no modification appeared to be necessary in the original design "beyond matters of detail."

When the Civil War broke out, Adams, true to the family traditions and his West Point training, entered the Army. As a colonel, first of the First Long Island Volunteers and later of Hawkins' famous Zouaves, he served in the Army of the Potomac and was wounded in the battle of Fair Oaks. A serious misunderstanding wihh General Casey cut short his career at the front, and he resigned and returned to New York. But his most notable service—at least in the eyes of the people of New York—was yet to come. When the draft riots broke out in July of 1863, Adams answered the call for officers and was placed in command of the troops in Printing House Square. He did not have to wait long for action. The mob, howling for the blood of Horace Greeley, stormed into the square the first day of the riots and headed for the Tribune Building. With his handful of troops, Adams skillfully warded them off, his nerve and quick wit "doing more to save the day for law and order than would the gunfire of a regiment."

After the war Adams became chief engineer of Brooklyn's department of city works, held that post for eight years, and in 1880 was appointed consulting engineer to the New York City department of public works. Space does not permit a detailed account of these years of municipal service, but the positions perhaps speak sufficiently for themselves.

Adams served the Society as Vice-President for six years, and as President for two. Near the end of his incumbency an event oc-

curred that illustrates the esteem to which the Society had already attained. The City of Providence had engaged an engineer to design and construct a sewerage system, and before it was completed considerable doubt arose as to its adequacy. There was tremendous agitation to replace the engineer and redesign the system, and the city council found it necessary to call for outside advice that would be without prejudice and not subject to local objections. So on October 4, 1875, they passed a resolution requesting the Society to appoint three competent persons to examine the system, report on its sufficiency, and make any recommendations for change they might deem to be necessary. The Society complied, Adams being one of the three selected. The committee's report, a few months later, thoroughly disposed of all the points at issue and justified the confidence the council had placed in the Society.

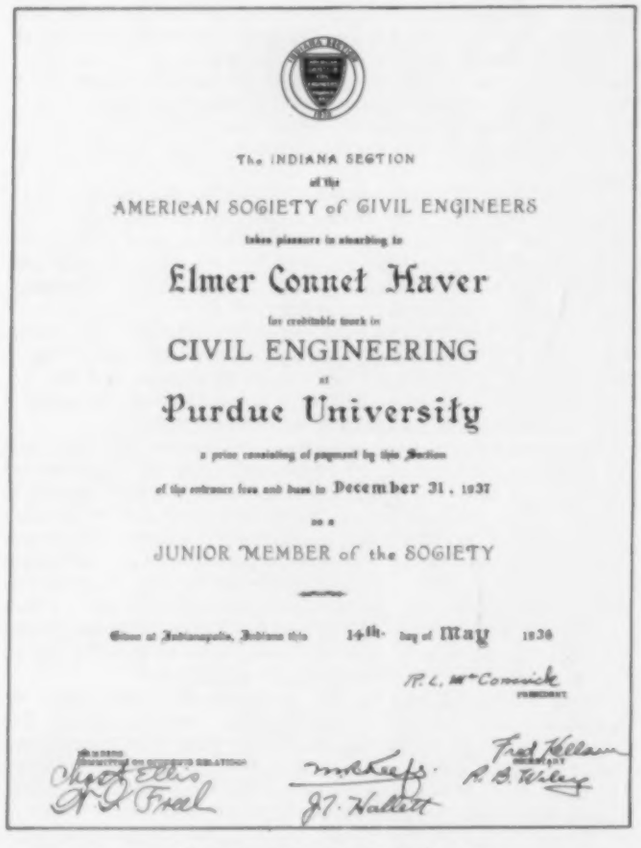
Adams died on December 13, 1899. *Engineering Record* in its next issue referred to him as "one of the most eminent engineers this country has produced."

"Throughout his life," the article continued, "he never evinced that exclusiveness which diminished both the popularity and influence of some of the family prominent in political fields. . . . A firm believer in what has been called the aristocracy of brains, he was as ready to give gratuitous assistance to the beginner in engineering work as to accept the retainer of a great city or wealthy corporation." He was a man of "gentle, lovable character, . . . broadminded and genial."

Student Prizes Awarded

IN ACCORDANCE with their usual custom, many of the Local Sections of the Society, during the past commencement season, presented awards to engineering students graduating with high academic distinction from colleges and universities within their territories. The recipient of such an award is allowed to join the Society as a Junior, after the application has been approved by the Board of Direction, the Local Section paying the initiation fee and dues for the first year. So far word of the following prize winners for 1936 has been received at Society Headquarters.

NAME OF STUDENT	COLLEGE	LOCAL SECTION GIVING AWARD
Robert H. Holcomb	University of Arizona	Arizona
Richard Evan Fisher	Ohio State University	Central Ohio
Clarence Scranton	University of Cincinnati	Cincinnati
William Rawle Christman	University of Akron	Cleveland
Edward Reginald Van Driest	Case School of Applied Science	
Paul Joseph Foeht	University of Colorado	Colorado
Robert Edward Austin	University of Florida	Florida
Paul Denney Bennett	Rose Polytechnic Institute	Illinois
Ralph Dean Claborn	Northwestern University	
Meir Pilch	Lewis Institute	
Blair Anderson Rieth	Purdue University	
James Donald Taylor	University of Illinois	
Gordon Arthur Zwissler	Armour Institute of Technology	
Elmer Connet Haver	Purdue University	Indiana
William Ernest Richter		
Carl R. Merriman	Rose Polytechnic Institute	
Merton Robert Cowan	State University of Iowa	Iowa
Richard Henry Heitman	Iowa State College	
Robert Francis Adams	Kansas State College	Kansas State
John S. McNown	University of Kansas	
Louis Clarence Bisso	Tulane University	Louisiana
Chester Paul Seiss	Louisiana State University	
George Everett Brandow	University of Southern California	Los Angeles
Sidney Bamberger	California Institute of Technology	
John Benjamin Armentrout	University of Maryland	Maryland
Harry F. Page, Jr.	Johns Hopkins University	
Myron Fickas Fifield	University of New Mexico	New Mexico
Carroll E. Withers	New Mexico State College	
Charles Eugene Cutts	University of Minnesota	Northwestern
Frank George Vessell		
William M. Simpson	University of Oklahoma	Oklahoma
Charles William Sullivan	Oklahoma Agricultural and Mechanical College	
Richard Adam Haber	University of Delaware	Philadelphia
Anthony J. Maiale	Drexel Institute	
William Graham Hall	University of Pittsburgh	Pittsburgh
Jack Edward McKee	Carnegie Institute of Technology	
George Ray Wells	West Virginia University	
Fredrick Teichert	University of California	Sacramento
Howard Louis John Gruber	Washington University	St. Louis
Eugene Joseph Daily	Missouri School of Mines and Metallurgy	
Frederick Louis Weiss	University of California	San Francisco
Clarkson Hill Oglesby	Stanford University	
William Lovejoy Shannon	University of Washington	Seattle
James Gerald Fogle	University of Idaho	Spokane
Roy Turney Jennings	University of Tennessee	Tennessee Valley
James Wilbur Johnson		
Adrian Woodrow Smith	University of Utah	Utah
Maurice Nelson McKendrick		
Clifford Dean Lawrence	Utah State Agricultural College	


The INDIANA SECTION
of the
AMERICAN SOCIETY of CIVIL ENGINEERS
takes pleasure in awarding to
Elmer Connet Haver
for creditable work in
CIVIL ENGINEERING
at
Purdue University
a prize consisting of payment by this Section
of the entrance fees and dues to December 31, 1937
as a
JUNIOR MEMBER of the SOCIETY
Given at Indianapolis, Indiana this 14th day of May 1936
R. L. McCormick
PRESIDENT

TYPICAL CERTIFICATE OF AWARD

Other awards of Junior membership in the Society made at commencement time were those of the Milo S. Ketchum award to Garry Heckman Austin, of the University of Colorado, made by the Colorado Section; and the Kreusi prize to Henry Ward Dougherty, of the University of Tennessee, made by the Tennessee Valley Section.

TRANSACTIONS Under Way

CONSIDERABLE PROGRESS has been made during the past summer in the final proofreading and printing of the 1936 TRANSACTIONS, to be numbered Vol. 101. This office work is expedited by the fact that there is a corresponding lull in the work on PROCEEDINGS due to the omission of the June and July numbers.

In accordance with the schedule, the complete volume has now been prepared and forwarded to the printer. In addition, a considerable part of the front section of Vol. 101 has been run off. The entire volume will be prepared for distribution according to the schedule in force for the past few years. That is, the paper-bound copies will be mailed with the October issue of PROCEEDINGS, and the cloth-bound and morocco-bound volumes will go out shortly afterward by regular mail.

The size of the current volume is between 1,700 and 1,800 pages, or about the same as in the past few years. An excellent variety and quality of papers, together with their discussions and closures by the authors, are in preparation for the permanent record of members.

Applications for Membership in the Society Continue to Rise

THE RATE at which applications for membership in the Society are received is partly an index of the economic situation and partly a reflection of the confidence felt by civil engineers in their professional society. About a year ago CIVIL ENGINEERING published a chart showing the greatly increased number of applications since 1932. Progress during the past year has been so striking that it is reported graphically in the accompanying Fig. 1, which brings the previous charts up to date.

Readers will doubtless recall that there is a provision by which graduates of engineering colleges of recognized standing may have their first year's dues remitted if they apply for membership in the Society within two months after graduation, and if they were members of their Student Chapter in good standing for six months prior to graduation. As the remitted dues amount to either $10 or $15, depending on where the applicant lives, the saving is substantial. As a result there is a rush of such applications during July and August, giving a sharp upward fillip to the cumulative curve of applications. This rush is over by the early part of September, and consequently it has been found desirable to use the date of approximately September 10 for the origin of curves showing the receipt of applications for membership. This also throws the effect of applications from recent graduates to the end of the curve.

That section of the curves between the origin and the early part of June therefore represents applications in which the preponderance is for corporate membership. Some Junior applications come in at all times of the year, but the bulk of applications prior to June are for the grades of Associate Member and Member.

In order to compare the applications received during June, July, and August of recent years, these sections of the curves have been replotted with an origin taken about June 10. That the graduating members from the Student Chapters are becoming more Society-conscious is clearly shown from the steep curve for 1936. This may also be inferred from the greatly increased activity within the Chapters themselves, as demonstrated by the heavy increase in correspondence with Headquarters, by the more extensive programs covered in the annual reports of the Chapters, and by the oral reports from Directors and Vice-Presidents of the Society as well as from the President, Secretary, and Field Secretary. Perhaps the greatest credit should go to the faculty advisers, whose influence on their protégés is so intimate and profound.

Such increases in the number of applications have severely taxed the capacity of the Headquarters' staff concerned with these matters. In spite of the fact that the professional record of a recent graduate consists of little more than the experience obtained while earning the degree, the labor of recording all the personal data, preparing copy for the printer, sending out the letters to references, and tabulating the replies, has kept four people fully occupied and has required additional assistance from several members of the staff who could be temporarily spared from other duties. It should be noted that the most meticulous care is necessary to avoid errors. Keeping membership matters straight and keeping them moving places a heavy burden of responsibility and hard work on the section of the staff concerned.

It would appear that the Society is gaining membership, both from older engineers and from recent graduates, at a healthy rate.

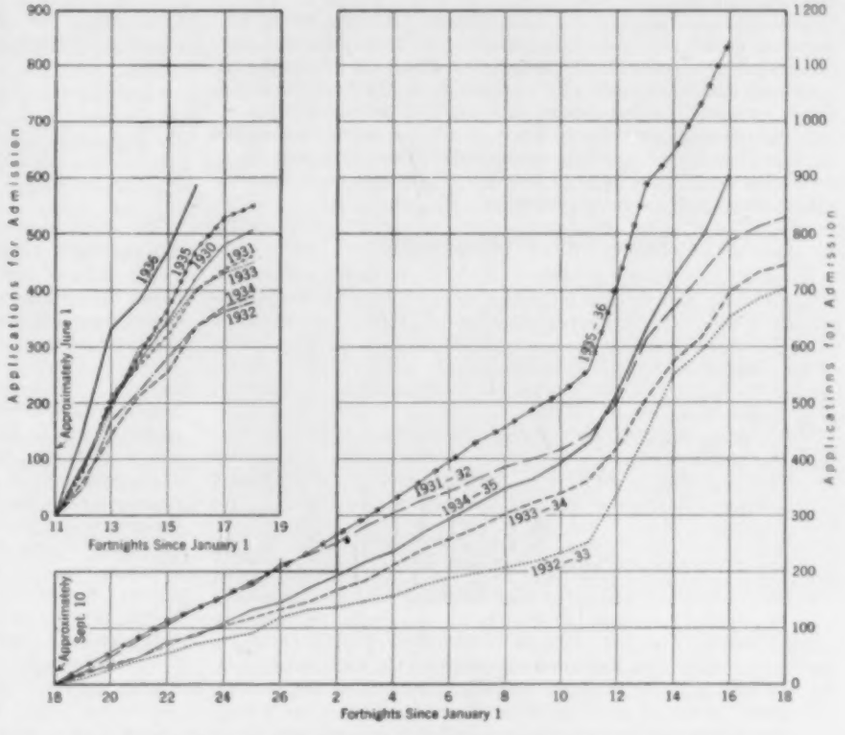


FIG. 1. APPLICATIONS RECEIVED BY FORTNIGHTS NUMBERED FROM JANUARY 1

American Engineering Council

The Washington Embassy for Engineers, the National Representative of a Large Number of National, State, and Local Engineering Societies Located in 40 States

REORGANIZATION OF GOVERNMENT AGENCIES

THE REORGANIZATION movement is gaining momentum in Washington. Three investigating committees are active, each moving cautiously. While the President's committee on administrative management is most active among government officials, no hearings are reported to be scheduled prior to November elections. In the meantime, there is much speculation regarding the seriousness of the reorganization intentions and the possibility that overlapping responsibilities may result in frustration of purpose.

Although similar studies in the past have not been very effective, the field has never seemed so ripe for reorganization and economy measures. Entering many new activities, the federal government has piled 40 new agencies on top of an already top-heavy administrative structure. An increase of more than 250,000 civilian employees since February 1933 has taken place in the civil service. Unofficial figures show the federal payroll for June 1936 was $326,159,486 for 4,664,732 employees. This is an obligation of about $2.65 per month against every man, woman, and child in the United States.

On the receiving end, it is estimated that 16,314,248 people have already received benefits from the emergency agencies. Emergency funds have gone into every state and territory, and congressional appropriations for that purpose run into many billions, with approximately $9,487,163,446 in a single session. The public debt at the close of the fiscal year for 1936 was approximately $33,779,000 and the total revenue for the 1936 fiscal year fell about $4,764,000 short of the total expenditures.

Regardless of past experience and political implication, the Byrd resolution with a continuing authority to bring administrative inefficiencies to the surface stands without handicap except for limitation of funds, until repealed by an act of Congress.

PUBLIC WORKS INVENTORY

The Public Works Inventory for 1936 is a joint undertaking by PWA and WPA under direction of the National Resources

Committee. It will be similar to the one made a year ago but is to include all public works possibilities for the next six years. The field work is to be done by local government employees of the cooperating agencies, who are to submit their estimates to the planning boards of 46 states. Project possibilities are to be classified by type, geographical location, and priority. Such inventories have not been important factors in the approval or rejection of individual projects but their continuation suggests that the Administration is not abandoning "made work" for the jobless.

THIRD WORLD POWER CONFERENCE

The engineering profession is honored by having one of its best-known members chosen as chairman of the Third World Power Conference meetings. Dr. William Durand, professor emeritus of mechanical engineering at Leland Stanford University, Palo Alto, Calif., will serve in that capacity. Dr. Durand is also a linguist, and will make his address of welcome in English, French, German, and Spanish.

Sponsored and financed jointly by the government and by the electrical industry of the United States, the Third World Power Conference is expected to engage the attention of engineers, scientists, and economists of the world in a study of "national power economy." The American committee is endeavoring to make it an international forum where all sides of questions growing up around public and private power policies can be presented to the entire world on a basis of free and frank discussion, without personalities, politics, or propaganda.

WHO'S WHO IN ENGINEERING

At the request of the publishers of the three earlier editions of *Who's Who in Engineering*, a sponsoring committee for the fourth edition has been appointed by Andrey A. Potter, president of Council, who will act as chairman. The following are members of the committee: A. W. Berresford, D. S. Kimball, C. F. Scott, George T. Seabury, C. E. Davies, H. H. Henline, A. B. Parsons, J. F. Coleman, and F. M. Feiker.

It is anticipated that the questionnaires outlining the qualifications for inclusion in the new edition will be mailed to members of the profession early in the fall. Eligible engineers will be listed without obligation. The new edition will be published in the spring of 1937.

VOCATIONAL CLINIC FOR EMBRYO ENGINEERS

Five out of six Washington high school graduates, picked by their respective principals as leaders in the graduating class of 1936, stated to a recent audience of the Rotary Club of Washington that they expected to be engineers. One had chosen civil, two mechanical, one electrical, and one management engineering. Dr. Mann, secretary emeritus of the American Council of Education, has suggested that the professional men in each city could well organize a "vocational clinic," and offer to young men and their parents the chance to learn the training for and opportunities of each profession.

In this connection, the Associated Technical Societies of Detroit recently held its first annual guidance meeting,* at which 123 boys and their parents were given an opportunity to consult representatives of various branches of the engineering profession.

August 10, 1936
Washington, D.C.

* *Editor's Note: An account of this meeting, which was an outgrowth of the activities of the Committee on Student Selection and Guidance of the Engineers' Council for Professional Development, appears on page 545 of "Civil Engineering" for August 1936.*

Lantern Lectures Available

THE SCHOOL YEAR of 1936–1937 will mark the eighth successive season in which the Society has offered to Student Chapters a selection from a number of lantern lectures, to supplement their other forms of instruction. A letter listing all these lectures, with suggestions for their use, will go forward to the secretary of each Chapter not later than October 1. Three new lectures are to be released this year, describing the Norris and Joe Wheeler dams of the Tennessee Valley project, and the San Francisco-Oakland Bay Bridge. The set of slides on Mississippi Valley flood control has been revised and brought up to date.

The other titles, all of which have proved popular in the past year, are as follows:

Carquinez Strait Bridge
Cascade Tunnel
Catskill Water Supply
Conowingo Hydroelectric Development
Coolidge Dam
Florianapolis Bridge
Hetch Hetchy Water Supply and Power Plant
Holland Tunnel
Miami Flood Control
Recent Power Developments at Niagara Falls
Westchester County Park System
Wilson Dam at Muscle Shoals

Reservations may be made at any time for the use of this material, which is sent free of charge to any Student Chapter.

Local Sections to Be Represented at Pittsburgh

A CONFERENCE of representatives from the Local Sections in the Northern Meeting Region will be held in Pittsburgh, Pa., at the time of the Fall Meeting of the Society. Vice-President Henry E. Riggs, chairman of the Northern Region Meetings Committee, will preside and will be assisted by the members of that committee, Directors F. A. Barbour, Charles B. Burdick, James L. Ferebee, H. S. Morse, C. E. Myers, C. Arthur Poole, and T. J. Wilkerson, and also by the members of the Annual Meeting Committee, Vice-President Edward P. Lupfer, chairman, and Directors O. H. Ammann, James K. Finch, Carlton S. Proctor and C. E. Trout.

Representatives from 29 Local Sections will receive partial payment of mileage to that meeting. The principal topics for discussion are those that have already been discussed in the Southern Region Conference at Hot Springs, Ark., and at the Western Region Conference at Portland, Ore. Thus the circuit of the country will be completed with the discussions at Pittsburgh, and the summary of opinions will be of great assistance to the Board of Direction in its study of Local Section problems.

Since the revival of Local Section conferences last fall, after a hiatus of four years, there has been encouraging evidence of renewed activity within the Local Sections. The exchange of information and opinion made possible by the conferences appears clearly to justify their continuance. The Local Sections are giving ample evidence that they have come of age and that more and more they are assuming a mature rôle in Society activities.

In and About the Society

THE Engineering Institute of Canada has extended a cordial invitation to members of the Society to attend its semicentennial celebration in Montreal, June 15–17, 1937. Arrangements are being made by the Institute for a number of technical papers of international scope and interest. The preliminary announcement goes on to suggest that those who wish to combine a vacation with the more serious side of the celebration will find every form of summer recreation at its best in eastern Canada during the month of June.

* * * *

ANNOUNCEMENT is made by the French Federation of Engineers of a congress of engineers from all parts of the world to be held in France in the fall of 1937. Invitations will be extended in due course to members of the Society. Among the topics to be discussed are the economic and social importance of the engineer, qualifications of the engineer, organization of the profession, and the engineer and legislation.

Preview of Proceedings

By HAROLD T. LARSEN, *Editor*

Papers on earth-fill dams, surveying, technical analysis, and express highways will constitute the technical contents of the September issue of "Proceedings."

SELECTION OF MATERIALS FOR ROLLED-FILL EARTH DAMS

On July 4, 1935, a paper entitled "Selection of Material for Rolled-Fill Earth Dams" was presented before the Irrigation Division at the Society's Convention in Los Angeles, Calif., by Charles H. Lee, M. Am. Soc. C.E. The paper was abstracted briefly in the September 1935 issue of CIVIL ENGINEERING, and those who wish a more comprehensive preview of the paper should refer to that article.

In its final form this paper, as published in PROCEEDINGS, is quite complete in that it contains operating data for use by the practicing engineer. Mr. Lee states that the material to be placed in the impervious part of a rolled-fill earth dam must satisfy five requirements: (1) It must be permanently stable against sloughing when saturated; (2) it must be reasonably water-tight against the maximum head of water; (3) it must be readily workable so that it can be properly spread and compacted in thin layers; (4) a mineral constituent composing the individual particles of the material must be insoluble; and (5) the cost of handling, including excavation, transportation, spread, and compacting, must be reasonable. Elaborating on the nature and importance of these five requirements, he ends his paper with practical suggestions for putting them into effect, including a number of curves with necessary exponents for different types of material.

SIMPLIFIED METHOD OF DETERMINING TRUE BEARINGS OF A LINE

A paper which, potentially, may find its way into the future manuals on surveying practice is entitled "Simplified Method of Determining True Bearings of a Line" by Philip L. Inch, Assoc. M. Am. Soc. C.E. It contains a description of his improved means for determining the azimuth of the sun and should prove especially useful to the practicing surveyor in finding true bearings of a line. The method has the advantage of being independent of time determination and computations, which many engineers avoid if possible.

Essentially, the purpose of the paper is to discuss the merits of a table of factors for the solution of the well-known equation in spherical trigonometry simplified as the mere subtraction or addition of two factors. One page of such tabular factors is presented as a means of appraising by discussion the potential value of a more complete table. If it seems desirable as the result of thorough discussion, the author proposes to submit as an appendix to his closing discussion the complete table embracing all latitudes from 31 deg north to 48 deg north, inclusive. It is expected that the table in this final form will incorporate useful suggestions as to scope and arrangement offered by discussers, and separate reprints of the entire paper with the table as an appendix will be available after publication in TRANSACTIONS. In this form the table will be useful for field consultation.

ANALYSIS OF CONTINUOUS FRAMES BY BALANCING ANGLE CHANGES

Since the introduction of the Cross method of distributing fixed-end moments, a number of variations have been proposed by students in this field from all over the world. In presenting another paper on this general subject—this one by L. E. Grinter, Assoc. M. Am. Soc. C.E.—the object is not to open the entire broad subject for discussion but simply the advantages and disadvantages of Professor Grinter's well-defined method. The analysis proposed is similar to, but not the same as, the original method, since the balancing procedure is performed upon the end rotations rather than upon the end moments of the members. It will be particularly valuable in determining the effect that slip in connections will have upon the distribution of stresses in rectangular frames as well as the effect of such slip upon secondary stresses. It will be found especially well adapted to the design of frames in which angular elastic deformations are considered.

The balancing of angle changes follows a series of definite steps parallel to those of the moment distribution method. When this analysis has been completed for any case, the designer has in hand all the data necessary for sketching the deflected structure. The method is particularly useful for studying secondary stresses in trusses and for investigating the effect of elastic distortion or slip in a riveted or welded connection of a continuous steel frame. Approximate influence lines for live load studies can be obtained very rapidly by this method. All in all, it is well adapted for extending the understanding of the structural analyst as to elastic relationship in frames and to enlarge his grasp of the problems ordinarily encountered in this field.

MODERN EXPRESS HIGHWAYS

It has been stated that, in the United States, an average slaughter of 3,000 persons per month occurs, due to some seven-eighths of a million automobile accidents. This is certainly a ghastly situation and one which should call for constant and concerted action. In so far as any substantial percentage of these fatalities may be affected by errors in highway design, there is an urgent need for a full discussion of his subject among civil engineers. Although there may be many thousands of miles in the 300,000 miles of main highways in the United States which cannot be made "express highways," and on which the volume of traffic does not justify such a design, there are localities in this country in which the high type of route discussed in this paper is warranted. That construction of highways to accommodate high-speed traffic should be determined through proper study by engineering planners, cannot be denied. The author, Charles M. Noble, Assoc. M. Am. Soc. C.E., barely states the problem and offers tentative solutions for thorough discussion.

SECTION OF HIGHWAY APPROACHING WILMINGTON, DEL.
70-Ft Parkway Constructed in 1933; 4 Lanes Southbound, 3 Northbound

In the early days of the Society, when the membership was smaller than it is today, it was sometimes customary at the regular technical meetings, to present a subject for discussion without scheduling a formal paper. After the meeting had been called to order, the chairman would call for impromptu opening remarks from some qualified engineer in the audience. These remarks would be followed by unusually valuable and spontaneous comments by other members in the audience.

This paper by Mr. Noble will impress readers as being in the nature of this broad, informal approach to an important basic problem confronting civil engineers today. He places before the Society a fundamental problem, suggests a few of its complicated features, and offers some possible tentative solutions. The remainder he leaves with the discussers, proposing to summarize and evaluate the best ideas expressed in discussion when the time comes for him to present his closing discussion on this subject.

Appointments of Society Representatives

FRED ASA BARNES, M. Am. Soc. C.E., represented the Society at the Sigma Xi semi-centennial, held at Cornell University on June 19 and 20 in connection with the summer meeting of the American Association for the Advancement of Science.

JAMES K. FINCH and R. S. KIRBY, Members Am. Soc. C.E., have been appointed Society representatives on the newly organized Joint Committee on Engineering History.

News of Local Sections

ALABAMA SECTION

On July 23 a regular meeting of the Alabama Section was held at the Birmingham plant of the Chicago Bridge and Iron Works. The principal order of business was the inspection of the plant, which is now engaged in the manufacture of 60-in. welded steel pipe for the Birmingham industrial water supply. At the conclusion of the meeting refreshments were served.

COLORADO SECTION

On July 26 about 30 members of the Junior Association of the Colorado Section and their friends visited the Colorado Springs region to study the various construction projects under way there. Among the places visited were the Pine Creek Bridge (shown in the

PINE CREEK BRIDGE, COLORADO SPRINGS, COLO.
Visited by the Junior Association of the Colorado Section on July 26

accompanying photograph), the Unitah Street and Mesa Road bridges, the new sewage-disposal plant at Colorado Springs, the South Catamount Creek Dam, and the Crystal Creek Dam. Some of the party also visited Pike's Peak. Russell E. Palmer, resident engineer inspector in Colorado Springs for the Federal Emergency Administration of Public Works, was host and chief guide.

DULUTH SECTION

A discussion of business matters occupied the session held by the Duluth Section on June 15. There were nine present. On July 20 members of the Section enjoyed their seventh annual golf tournament. There were 25 present at the luncheon, held at the Ridgeview Golf Club in advance of the tournament, while 20 took part in the game itself.

GEORGIA SECTION

Numerous business matters were discussed at a luncheon meeting of the Georgia Section held in Atlanta on July 13. The speaker on this occasion was Paul Weir, who is in charge of Atlanta's filtration plant. Mr. Weir illustrated his talk by showing numerous photographs and samples of materials that are used in the plant. The plant in question, which is now 42 years old, produces water as sterile as pasteurized milk and sends it through 700 miles of pipe to the consumer.

LOS ANGELES SECTION

A special meeting of the Los Angeles Section was called on July 28 in honor of Daniel W. Mead, President of the Society; George T. Seabury, Secretary; and Walter E. Jessup, Field Secretary. After dinner there was a short program of Spanish music and dancers. Mr. Jessup spoke briefly on the subject of Society activities, and Director Raymond A. Hill gave a report of the meeting of the Board of Direction at the Annual Convention. Local Section representatives also gave brief reports of the Convention. Dr. Mead then gave an informal talk on the engineering profession and the future of the Society. There were 90 present, including 10 former presidents of the Section.

NEW MEXICO SECTION

A meeting of the New Mexico Section was called to order at the University of New Mexico at Albuquerque on March 7. After a brief business discussion Ficas Fifield, a member of the University of New Mexico Student Chapter, outlined the activities of the Chapter during the past year and urged the members of the Section to attend Chapter meetings. Then Charles E. Erdman, of the U. S. Geological Survey, spoke on the topic of the geophysical examination of dam sites, emphasizing particularly the Pine River Dam site. On May 18 a meeting of the Section was held at Santa Fe. The speaker on this occasion was John R. Noyes, captain, Corps of Engineers, U. S. Army, who described the Conchas Dam.

NORTHWESTERN SECTION

There were 31 present at a meeting of the Northwestern Section held in the Minnesota Union Building in Minneapolis on June 2. The presentation of student prizes offered annually by the Section took place, and there was a discussion of business matters. The technical program consisted of an interesting review of railroad history in the United States. This was given by Henry Dougan, assistant general auditor for the Great Northern Railway.

SACRAMENTO SECTION

The contractor's problem in carrying out the plans and specifications of engineers and architects was the subject of a talk given by Walter H. Campbell, general contractor, before the Sacramento Section on June 2. At a meeting held on June 9, G. A. Tilton, Jr., assistant construction engineer of the California Division of Highways, described the use of convict labor in highway construction, and on June 16 the speaker was Lester S. Ready, consulting electrical engineer of San Francisco. Through the courtesy of J. B. Brown, former president of the Section, motion pictures of the construction of Norris Dam were shown at a meeting held on June 23, and the speaker at the final meeting of the month was H. H. Jaqueth, engineer for the Sacramento City Planning Commission. The average attendance at these weekly luncheon meetings was 35.

TACOMA SECTION

A special luncheon meeting of the Tacoma Section was held in honor of Daniel W. Mead, President of the Society, and George T. Seabury, Secretary of the Society, at the Winthrop Hotel in Tacoma on July 21. Mr. Seabury gave a résumé of Society activities during the past few years, calling special attention to the action taken by Society officials to alleviate the unemployment situation in the engineering profession. Dr. Mead then gave a talk in which he stressed the importance of becoming familiar with the activities of the Society. He also sketched the history of the Society and directed attention to the things that are important in regard to its future.

Student Chapter Notes

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

The Agricultural and Mechanical College of Texas Student Chapter reports the close of an unusually successful school year. Students and outside speakers presented papers at the 12 meetings, which had a total attendance of 670. The list of speakers included the names of Walter H. Meier, president of the Texas Section; Roy M. Green, president of Western Laboratories, Inc., Lincoln, Nebr.; Henry E. Riggs, Vice-President of the Society; J. C. Carpenter, of the U. S. Bureau of Public Roads; and Walter E. Jessup, Field Secretary of the Society. The Chapter played an active rôle in the engineering day show held at the college, and senior-class members of the Chapter made a three-day inspection trip to visit engineering projects at Dallas and Fort Worth, Tex.

ANTIOCH COLLEGE

Most of the 14 meetings held by the Antioch College Student Chapter during the past school year were conducted on a seminar basis—members reported on articles appearing in national engineering publications, and general discussion followed. Several members attended the regional conference at Zanesville, Ohio, sponsored by the Cleveland Section, which they found most worth while. A special dinner meeting was held on May 18 in honor of Field Secretary Jessup. Another dinner meeting, on June 15, was in honor of Prof. T. C. Lloyd, who has left the college to go into industry.

BROWN UNIVERSITY

The Brown University Student Chapter recently completed its first year, during which it held nine meetings, with a total attendance of 312. Some of the speakers at these gatherings were Harold E. Miller, contact member for the Chapter; Stanley Dore, associate civil engineer for the Massachusetts Metropolitan District Water Supply Commission; Robert Ridgway, Past-President of the Society; D. B. Steinman, consulting engineer of New York; Field Secretary Jessup; and Alton C. Chick, engineer, Manufacturers' Mutual Fire Insurance Company.

BUCKNELL UNIVERSITY

During the recently completed academic year the Bucknell University Student Chapter held seven meetings, with a total attendance of 100. Several guest speakers were heard at these sessions—among them Willis Whited, former contact member for the Chapter, and Field Secretary Jessup. Members of the Chapter attended the Annual Meeting of the Society in New York and the Student Chapter conference held at Pennsylvania Military College. They also made inspection trips to engineering projects in the vicinity of Philadelphia and Harrisburg, Pa.

CARNEGIE INSTITUTE OF TECHNOLOGY

A large number of student papers were read at the weekly meetings held by the Carnegie Institute of Technology Student Chapter during the past year. On other occasions there were outside speakers, the list including C. B. Jansen, of the Dravo Construction Company; A. R. Ellis, vice-president of the Pittsburgh Testing Laboratory; A. V. Spinosa, vice-president of the Penn Metal Company; George W. Thomas, chief engineer for the H. H. Robertson Company; C. J. Code, division engineer for the Pennsylvania Railroad; B. C. Fowlkes, of the U. S. Engineer Office at Pittsburgh; and Field Secretary Jessup. The outstanding social event was a dance, which was held in the spring. There was 100 per cent enrolment in the Chapter during the year.

CALIFORNIA INSTITUTE OF TECHNOLOGY

Following a policy of making as many inspection trips as possible, the California Institute of Technology Student Chapter took two long trips during the past year, in addition to visiting several places of local engineering interest. These two major trips included inspection of the bridges in San Francisco and of the course of the Metropolitan Aqueduct. The crowning event of the season was the dinner meeting, at which the Chapter played host to the Los Angeles Section of the Society. Several interesting outside speakers were heard at the 14 meetings held during the year.

GROUP FROM CALIFORNIA INSTITUTE OF TECHNOLOGY STUDENT CHAPTER VISITS THE PARKER DAM SITE

COLLEGE OF THE CITY OF NEW YORK

Unusual success marked the activities of the College of the City of New York Student Chapter during the past year. In addition to holding 20 technical meetings, the Chapter participated in various professional and social phases of college life, including the

SOME MEMBERS OF THE COLLEGE OF THE CITY OF NEW YORK STUDENT CHAPTER

annual engineers' open house, smokers, several dances, and numerous inspection trips. The Chapter also conducts *Tech News*, a three-page mimeographed newspaper, containing news of the Chapter and of the school of technology, which is issued weekly. Members of the Chapter are also on the board of the *Tech Journal*, the official publication of the school. In the spring the Chapter was host at the afternoon session of the metropolitan conference of Student Chapters.

CATHOLIC UNIVERSITY OF AMERICA

The annual report of the Catholic University of America Student Chapter shows 100 per cent enrolment during the past academic year. Illustrated lectures loaned by the Society furnished the nucleus of entertainment at a number of the 14 meetings, and student papers were also enjoyed. Several inspection trips were made during the year, the list of places visited including the laboratory of the U. S. Bureau of Public Roads at Arlington, Va., and the U. S. Bureau of Standards.

CLARKSON COLLEGE OF TECHNOLOGY

Two inspection trips were enjoyed by the Clarkson College of Technology Student Chapter during the past year. One of these took in the engineering projects in the New York City area, and the other the water-purification plant at Ottawa, Canada. The Chapter boasted 100 per cent membership, and there were eight meetings, the total attendance at these sessions being 320. Among the speakers at the meetings were Lewis K. Sillcox, vice-president of the New York Air Brake Company, and Field Secretary Jessup.

CLEMSON AGRICULTURAL AND MECHANICAL COLLEGE OF SOUTH CAROLINA

Illustrated lectures furnished by the Society were shown at several of the 1935–1936 meetings of the Clemson Agricultural and Mechanical College of South Carolina Student Chapter. The list of outside speakers included F. R. Sweeny, consulting engineer of Anderson, S.C.; Field Secretary Jessup; and M. R. Morgan. The Chapter entered a number of interesting exhibits in the third biennial exposition, held by the Clemson College schools of engineering and architecture on March 29 and 30.

COLUMBIA UNIVERSITY

The Columbia University Student Chapter completed a successful year with a 100 per cent membership of those eligible. Nineteen meetings were held, at two of which illustrated lectures furnished by the Society were used. Among the speakers from out-

side the student body were Gavin Hadden, New York civil engineer, who spoke on functional design and its application to sport stadiums; and Otis E. Hovey, consulting engineer of New York, who gave an address on movable bridges. David C. Williams, a student member, read a paper which was abstracted for the April 1936 issue of CIVIL ENGINEERING. The plan tried the preceding year, of conducting a course in public speaking in conjunction with the second semester Chapter meetings, was again followed with even greater success. The spring conference of Metropolitan Section Student Chapters was held in part at Columbia.

COOPER UNION

The activities of the Cooper Union Student Chapter are closely interwoven with the regular curriculum. The Chapter has played a large part in conducting and providing speakers for the special weekly hour devoted to "professional aspects" by the Institute of Technology. Field Secretary Jessup and contact member William H. Yates both addressed the students on such an occasion. The Society's illustrated lectures were frequently used by students in presenting papers before the weekly senior engineering conference, and on other occasions. Among the outside speakers who addressed the Chapter were Gavin Hadden, consulting civil engineer of New York; Charles L. Crandall, resident engineer of the Midtown Hudson Tunnel; and J. W. Pickworth, designer of the Hayden Planetarium in New York. The Chapter is proud of its 100 per cent membership of those eligible.

CORNELL UNIVERSITY

During the past school year the Cornell University Student Chapter, in conjunction with the Ithaca Section of the Society, was host to a regional conference of Student Chapters and Local Sections. Another high light of the year was an inspection trip to New York, made during the Christmas holidays, that included many points of engineering interest. There were eight technical meetings, with a total attendance of 520. Among the speakers on these occasions were Homer R. Seely, resident engineer for the Triborough Bridge Authority; S. C. Hollister, director of the school of engineering; and Field Secretary Jessup.

DARTMOUTH COLLEGE (THAYER SCHOOL OF CIVIL ENGINEERING)

Students were responsible for the technical programs at a number of the 1935–1936 meetings of the Dartmouth College Student Chapter. These papers covered a wide variety of timely engineering topics, and many of them were illustrated by lantern slides or motion pictures. The list of outside speakers heard on other occasions included John Minnich, construction engineer; Otis E. Hovey, consulting engineer of New York City; and Field Secretary Jessup. An outing was enjoyed in the fall. There was 100 per cent enrolment of those eligible for membership in the Chapter.

DREXEL INSTITUTE

Guest speakers were enjoyed at a number of the 1935–1936 meetings of the Drexel Institute Student Chapter. The list of these included C. L. Appleton, engineer of construction for the Delaware River Joint Commission; O. E. McMullen, regional structural engineer for the Portland Cement Association; Harry J. Engel, assistant engineer for Modjeski, Masters, and Case; G. P. Bullard and H. J. Stetina, of the Bethlehem Steel Company; J. B. Letherbury, of the New York Shipbuilding Corporation; W. G. Stevens, Jr., of the Philadelphia and West Chester Traction Company; and Field Secretary Jessup.

DUKE UNIVERSITY

Students were responsible for a number of the programs arranged by the Duke University Student Chapter during the past year. On other occasions the Society's illustrated lectures or outside speakers were enjoyed. In all, there were 14 meetings, with a total attendance of 293. There was 100 per cent enrolment of those eligible for membership in the Chapter.

GEORGE WASHINGTON UNIVERSITY

At the 12 meetings held by the George Washington University Student Chapter during the 1935–1936 school year 19 papers were presented by students. A "mixer meeting" held on October 2 was most successful in getting all the engineering students together. All functions were written up for the university paper. On May 7 the Chapter was host to the first annual convention of the Student Chapters in the area—those from Johns Hopkins University, the University of Maryland, and the Catholic University of America. Representatives were also present from the Virginia Polytechnic Institute, the Virginia Military Institute, and the University of Virginia. This is considered to have been the most successful year the Chapter ever had.

GEORGIA SCHOOL OF TECHNOLOGY

During the past school year the Georgia School of Technology Student Chapter held six meetings, at which the total attendance was 75. Several student papers were presented at these sessions, and on one occasion a talk was given by Andrew J. Cooper, chief draftsman and structural engineer for Robert and Company, of Atlanta. In the spring the Chapter sponsored a dance.

HARVARD UNIVERSITY

The Harvard University Student Chapter began its 1935–1936 school year by making an inspection trip to the Swift River Reservoir in western Massachusetts. Later the Chapter visited the plant of the American Steel and Wire Company at Worcester. The ten technical meetings held during the year boasted a total attendance of 897. Among the speakers on these occasions were Rudolf Bernhard, chief engineer of the German State Railways; Frank M. Lewis, of the Webb Institute of Naval Architecture; L. K. Sillcox, vice-president of the New York Air Brake Company; Karl von Terzaghi, visiting professor of soil mechanics at the university; Harald M. Westergaard, professor of theoretical and applied mechanics at the University of Illinois; and Jesse Ormondroyd. There was 100 per cent enrolment of those eligible for membership.

IOWA STATE COLLEGE

Among the special events included in the twelve meetings of the Iowa State College Student Chapter were a lecture on surveying at the South Pole by Thomas Poulter, Byrd's second in command on his last expedition, and a showing of the Babcock and Wilcox Company's film of Boulder Dam. This motion picture was accompanied by addresses by W. A. Skinner, representative of the company, and Prof. H. J. Gilkey, a concrete consultant on the project. Speakers at other meetings included J. S. Dodds, professor of civil engineering; R. A. Moyer, associate professor of highway engineering; Anson Marston, retired dean of engineering; Frank Kerekes, professor of structural engineering; M. B. Morris, of the Iowa State Highway Commission, contact member; and Field Secretary Jessup, who was photographed with the Chapter, as shown in the accompanying illustration. A week's inspection trip to Chicago included visits to many points of engineering interest.

IOWA STATE COLLEGE STUDENT CHAPTER

JOHNS HOPKINS UNIVERSITY

Members of the Johns Hopkins University Student Chapter enjoyed nine meetings during the past academic year. Among the outside speakers appearing on these occasions were Henry G. Perring, consulting engineer and architect, who discussed the subject of housing; Elton Wade, a geologist with the second Byrd Antarctic expedition, who presented an illustrated lecture dealing with this expedition; and Nathan L. Smith, chief engineer of the Maryland State Roads Commission, who described the results of the recent floods. In the spring the Chapter served as joint sponsor for the annual engineers' dance.

Kansas State College

Students, members of the faculty, and outside speakers collaborated to make the 1935–1936 meetings of the Kansas State College Student Chapter interesting and varied. On the lists of outside speakers were W. E. Gibson, engineer of tests for the Kansas State Highway Commission; Theodore A. Leisen, Director of the Society; Field Secretary Jessup; Henry E. Riggs, Vice-President of the Society; and H. D. Barnes, State Highway Engineer of the Kansas State Highway Commission. On May 11 a smoker was held in the Community House, the principal speaker on this occasion being S. A. Nock, vice-president of the college. Several members of the Chapter also gave short talks at this gathering. The Chapter boasted 100 per cent membership.

Lafayette College

Several interesting and worth-while lectures marked the year's activities of the Lafayette College Student Chapter. Maj. William Bowie, Chief of the Division of Geodesy, U. S. Coast and Geodetic Survey, presented an illustrated lecture on surveying work throughout the country; Lynn Perry, assistant professor of hydraulics and sanitary engineering at Lafayette, spoke on his early days in engineering work; and A. B. Cleaves, of the Lafayette geology department, showed motion pictures of his travels in Greenland. At the first meeting of the school year Field Secretary Jessup and E. L. Durkee, contact member, spoke on the Society's activities.

Lehigh University

Several interesting field trips supplemented the regular work of the Lehigh University Student Chapter during the recently completed school year. Among the places visited were the McClintic-Marshall plant at Pottstown, Pa., and many points of engineering interest in and about New York City. On the list of outside speakers were H. W. Lawson, designing engineer for the McClintic-Marshall Corporation; E. L. Durkee, assistant engineer for the Bethlehem Steel Company; William Bowie, chief of the Division of Geodesy of the U. S. Coast and Geodetic Survey; and Thaddeus Merriman and Alexander Potter, consulting engineers of New York.

Louisiana State University

Members of the Louisiana State University Student Chapter displayed unusual interest in the 1935–1936 activities of their organization. Several meetings proved of special value, the speakers being Robert J. Wood, who gave an illustrated lecture on the construction of the George Washington Bridge; C. G. Cappel, who described by means of motion pictures the process of moving a six-story brick building a distance of several hundred feet; and Lt. M. H. Reese, of the U. S. Coast and Geodetic Survey, who explained aerial photographic methods. The Chapter participated actively in the annual engineering day held in the spring.

Lewis Institute

Illustrated lectures loaned by the Society and student papers formed the nucleus of entertainment at the 1935–1936 meetings of the Lewis Institute Student Chapter. Among the guest speakers who were heard at the 20 meetings were Daniel W. Mead, President of the Society; W. S. Monroe, president of Sargent and Lundy, of Chicago; Field Secretary Jessup; and Alfred Herz, of the Public Service Company of Northern Illinois. The special activities of the Chapter included a father-and-son dinner, a banquet, and participation in the annual engineers' open house held by the school.

MEMBERS OF THE LEWIS INSTITUTE STUDENT CHAPTER

Manhattan College

During the past school year there was 100 per cent enrolment in the Manhattan College Student Chapter. There were ten meetings, with a total attendance of 700. At these sessions some of the outside speakers were Arthur G. Hayden, designing engineer for the Westchester County Park Commission; Herbert M. Hale, consulting engineer; Arthur V. Sheridan, contact member for the Chapter; and Field Secretary Jessup. On several occasions during the year motion pictures were shown through the courtesy of the Chevrolet Motor Company.

Marquette University

Students, members of the faculty, and outside speakers cooperated in the presentation of technical programs at the 1935–1936 meetings of the Marquette University Student Chapter. In all, there were seven meetings, with a total attendance of 128. On one occasion E. D. Roberts, head of the department of civil engineering at the university, showed motion pictures depicting new methods of sewer construction, and on May 8, Field Secretary Jessup gave a talk. The Chapter sponsored its annual picnic in the spring.

Massachusetts Institute of Technology

Members of the Massachusetts Institute of Technology enjoyed hearing both faculty members and outside speakers at their ten meetings held during the recently completed school year. Among these were Karl Kennison, assistant chief engineer of the Metropolitan District Water Supply Commission; Dr. Harlan T. Stetson, of Harvard University; Charles M. Spofford, consulting engineer of Boston; Benjamin K. Hough, Jr., of the U. S. Engineer Office at Eastport, Me.; Albert E. Kleinert, of the Massachusetts Department of Public Works; and Field Secretary Jessup. During the year motion pictures were shown through the courtesy of Stone and Webster and the Hanna Steel Corporation.

Michigan College of Mining and Technology

The showing of illustrated lectures furnished by the Society and the presentation of student papers comprised the technical programs enjoyed by members of the Michigan College of Mining and Technology Student Chapter during the past year. The opening session was addressed by Grover C. Dillman, president of the college, who spoke on the advantages of student membership in professional societies. The other speakers heard were Field Secretary Jessup and W. Kaiser, of the Houghton County Road Commission.

Michigan State College

The numerous activities of the Michigan State College Student Chapter during the school year 1935–1936 included three inspection trips, preparation of an exhibit for the road show sponsored by the Michigan Association of Road Commissioners and Engineers, and a joint banquet with the Detroit and Lansing engineering societies. Another banquet was given to the senior members of the Chapter by the Lansing Society of Engineers. Among the speakers at the regular meetings were C. H. Olmstead, consulting engineer of Chicago; R. G. Dagg, of the Jeffreys Company of Detroit; L. J. Rothgery, research assistant at the college's engineering experiment station; and G. R. Kennedy, of the Michigan State Highway Department.

Montana State College

Thirty meetings, with a total attendance of about 450, were held during the past academic year by the Montana State College Student Chapter. At about half of these, illustrated lantern lectures furnished by the Society were shown. Most of the meetings were addressed by student members, who gained valuable experience in public speaking by presenting a variety of subjects, including their experiences in summer work. In November Prof. E. R. Dye gave a talk on the design of earthquake-resistant structures, which was of timely interest because of the recent heavy shocks in the Montana area.

Missouri School of Mines and Metallurgy

The Missouri School of Mines and Metallurgy Student Chapter reports 100 per cent enrolment of those eligible for membership

during the past year. Numerous meetings were enjoyed, the speakers on some of these occasions being M. S. Murray, WPA administrator for the state of Missouri; David J. Perry, of the Missouri State Highway Department; R. A. Kirkpatrick, of the Union Pacific Railroad; Field Secretary Jessup; H. S. Pence,

MISSOURI SCHOOL OF MINES AND METALLURGY STUDENT CHAPTER

resident engineer at Alton Dam; B. D. Shnable, of the Great Lakes Dredge and Dock Company, Chicago; Robert Wood, district engineer for the American Institute of Steel Construction; John H. Porter, consulting engineer of St. Louis; and A. P. Greensfelder, president of the Fruin-Colnon Contracting Company. On one occasion motion pictures of Boulder Dam were shown through the courtesy of the U. S. Department of the Interior.

NEWARK COLLEGE OF ENGINEERING

A number of interesting speakers addressed the 1935–1936 meetings of the Newark College of Engineering Student Chapter—among them Allan R. Cullimore, president of the college; C. W. Dunham, assistant engineer of the Port of New York Authority; George E. Barnes, head of the department of civil engineering at the Case School of Applied Science; J. B. Babcock, professor of railway engineering at Massachusetts Institute of Technology; Charles P. Berkey, professor of geology at Columbia University; Charles Gilman, contact member for the Chapter; and Field Secretary Jessup. Students presented papers at other sessions. In all, there were 13 meetings, with a total attendance of 783.

NEW MEXICO STATE COLLEGE (D. B. JETT STUDENT CHAPTER)

A partial report from the New Mexico State College Student Chapter indicates that there were 13 meetings during the past year, with a total attendance of 144. The entertainment on these occasions was supplied by students and guest speakers. On April 17 and 18 a two-day session, with the New Mexico Section of the Society, proved of great interest.

NEW YORK UNIVERSITY

Students were responsible for the technical programs presented at most of the 1935–1936 meetings of the New York University Student Chapter. Their papers represented a great deal of interesting work and research. Smokers were held once a month, and well-known engineers were often present on these occasions to give talks. Inspection trips were made to various points of local interest, including the Midtown Tunnel, and a three-day trip through New Jersey and Pennsylvania was also enjoyed. Eleven members of the Chapter are on the staff of the *New York University Quadrangle*. This magazine, which is published monthly by engineering students of the university, has received unusually wide commendation.

NORTH CAROLINA STATE COLLEGE

Among the professional activities in which the North Carolina State College Student Chapter participated during the 1935–1936 school year was the annual engineers' fair held by the college on April 3 and 4. The exhibits shown by the Chapter on this occasion received a great deal of favorable comment. In addition to 16 technical and business sessions held during the year, a smoker, dance, and "stunt night" were also enjoyed. On April 7 a special meeting was held in honor of Field Secretary Jessup, who made an address.

NORTH DAKOTA STATE COLLEGE

The North Dakota State College Student Chapter held four meetings, with a total attendance of 92, during the recently completed school year. On November 21 the Chapter held a joint meeting with the local Engineers' Club, and on May 4 Field Secretary Jessup was present to give a talk on the organization and activities of the various Student Chapters throughout the country. The other sessions were addressed by representatives of the U. S. Corps of Engineers and of the Portland Cement Association.

OHIO NORTHERN UNIVERSITY

The Ohio Northern University Student Chapter reports the conclusion of an unusually successful year, with 100 per cent enrolment of those eligible for membership. Students presented papers at some of the 20 meetings, and others were addressed by outside speakers. Special activities included an inspection trip to the Champion Iron Works; a two-day trip to the Muskingum Watershed Conservancy Project; and participation in the annual engineering week held by the university in February. Members of the Chapter have also been very active in extra-curricular activities, having organized an engineers' speaking society and a soft-ball team. On May 20 Field Secretary Jessup gave a talk.

OHIO STATE UNIVERSITY

Faculty members gave a number of talks before the 1935–1936 meetings of the Ohio State University Student Chapter. On other occasions student papers or the Society's illustrated lectures were

MEMBERS OF OHIO STATE UNIVERSITY STUDENT CHAPTER

presented. At a dinner meeting held on January 23 John H. Gregory, professor of civil and sanitary engineering at the Johns Hopkins University, was speaker. In all, there were 13 meetings, with a total attendance of 468.

OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE

Among the speakers who addressed the 1935–1936 meetings of the Oklahoma Agricultural and Mechanical College Student Chapter were Field Secretary Jessup, who discussed the activities of the Society; R. E. Kirkham, whose topic was biological surveying; B. S. Myers, consulting structural engineer of Oklahoma City, who discussed bow-string trusses; and J. C. Carpenter, senior highway engineer for the U. S. Bureau of Public Roads. On April 4 the Chapter was host to the Oklahoma Section of the Society. The year's social events included two picnics.

OREGON STATE AGRICULTURAL COLLEGE

Students, members of the faculty, and outside speakers cooperated during the past year to make the programs presented at the seven meetings of the Oregon State Agricultural College Student Chapter interesting. On the list of guest speakers were Glenn S. Paxson, assistant bridge engineer for the Oregon State Highway Commission; John W. Cunningham, consulting engineer of Portland, Ore.; and Harold A. Rands, senior engineer, U. S. Engineer Office at Eugene, Ore. Members of the Chapter visited Bonneville Dam during the year, and they played an active part in the annual engineers' day held at the college on May 16.

PENNSYLVANIA MILITARY COLLEGE

During the 1935–1936 school year the Pennsylvania Military College Student Chapter had 100 per cent enrolment of those eligible for membership. Inspection trips were made to the plant of the Philadelphia Power and Electric Company at Chester, Pa.; the Sun Shipbuilding Company; the Franklin Institute Planetarium; and the Ford Assembling Plant at Philadelphia. Among the outside speakers who addressed technical sessions were C. E. Myers, Director of the Society and consulting engineer of Philadelphia; Joseph G. Shryock, chief engineer of the Belmont Iron Works; and Field Secretary Jessup. On April 20 the Chapter was host to the second annual Student Chapter convention, held under the auspices of the Philadelphia Section. And on May 4 members of the Chapter were dinner guests of the Juniors of the Section at the Engineers' Club in Philadelphia.

PENNSYLVANIA STATE COLLEGE

Students, members of the faculty, and outside speakers cooperated to make the 1935–1936 meeting programs of the Pennsylvania State College Student Chapter interesting and informative. At a meeting held on October 28 Field Secretary Jessup gave a talk on the history and current activities of the Society, and in May the annual civil engineers' banquet took place. In April a visit was made to the Rockview Penitentiary for the purpose of inspecting its many engineering features. There were 14 meetings, with a total attendance of 538.

POLYTECHNIC INSTITUTE OF BROOKLYN

The Polytechnic Institute of Brooklyn Student Chapter reports 100 per cent enrolment during the year. Several interesting speakers were heard at the six meetings—among them E. H. Corlett, of Fairchild Aerial Surveys; H. L. Stevenson, of the Babcock and Wilcox Corporation; Robert Ridgway, Past-President of the Society and contact member for the Chapter; Field Secretary Jessup; and Charles Gilman, vice-president of the Massey Concrete Products Corporation. On November 15 the Chapter visited the Triborough Bridge.

PRINCETON UNIVERSITY

Several inspection trips to places of engineering interest in New York and Philadelphia enhanced the 1935–1936 activities of the Princeton University Student Chapter. There were five technical meetings, with a total attendance of 95. Responsibility for the programs on these occasions was equally divided between students and outside speakers, the latter including Dr. Rudolph Bernhard, whose topic was "Research Work in Europe in the Last Ten Years"; Field Secretary Jessup, who gave a résumé of the history of the Society; and Sigvald Johannesson, designing engineer for the New Jersey State Highway Commission, who discussed the economics of highway engineering.

PURDUE UNIVERSITY

An interesting group of speakers appeared on the technical programs presented at the 1935–1936 meetings of the Purdue University Student Chapter. This list included Henry E. Riggs, Vice-President of the Society; H. S. Morse, general manager of the Indianapolis Water Company; William S. Housel, assistant professor of civil engineering at the University of Michigan; Lawrence T. Wiley, of the Illinois State Highway Commission; and Field Secretary Jessup. At a special meeting, held in conjunction with local student branches of other engineering societies, Miss Amelia Earhart gave an interesting account of her flight from Hawaii to the United States. One of the special events of the year was a two-day inspection trip through northern Indiana, which was made under the guidance of the Indiana Section of the Society.

RENSSELAER POLYTECHNIC INSTITUTE

The six meetings held by the Rensselaer Polytechnic Institute Student Chapter during the past year attracted a total attendance of 1,015. On these occasions the presentation of student papers and talks by outside speakers comprised the technical programs. Among the guest speakers were D. B. Steinman, consulting engineer of New York; Prevost Hubbard, chemical engineer for the Asphalt Institute; Field Secretary Jessup; and Carlton S. Proctor, consulting engineer of New York. Many members of the Chapter attended the Student Chapter conference held at Ithaca, N.Y., on March 19.

RHODE ISLAND STATE COLLEGE

The Rhode Island State College Student Chapter reports the completion of a very successful year. Several meetings were addressed by members of the Chapter. Others speakers were Mason J. Young, major, Corps of Engineers, U. S. Army; Field Secretary Jessup; Henry W. Durham, superintendent of development, Resettlement Administration; and L. M. Colwell, district manager of the Jeffrey Manufacturing Company. Two of the Society's illustrated lectures were shown during the year, and senior class members of the Chapter enjoyed several field trips.

RICE INSTITUTE

Varied programs were presented at the 1935–1936 meetings of the Rice Institute Student Chapter. In addition to student and faculty speakers at these gatherings, there were several guest speakers—among them Henry E. Riggs, Vice-President of the Society; Robert J. Cummins, consulting engineer of Houston, Tex.; Walter P. Moore, structural engineer of Houston; Daniel W. Mead, President of the Society; and Field Secretary Jessup. The Chapter helped sponsor the ninth biennial engineering show, which was held on April 17 and 18.

ROSE POLYTECHNIC INSTITUTE

There was 100 per cent enrolment in the Rose Polytechnic Institute Student Chapter during the 1935–1936 school year. On October 11 and 12 the senior-class members of the Chapter were guests of the Indiana Section of the Society on an inspection trip that took in engineering and industrial features in northern Indiana. At one of the seven meetings motion pictures were shown through the courtesy of the American Institute of Steel Construction. The season's social events included a banquet and smoker.

SOUTH DAKOTA STATE COLLEGE

Among the features that characterized the nine meetings held by the South Dakota State College Student Chapter were motion pictures of pipe-line construction in Alabama and of the Galesburg Sanitary Drainage Canal. A special meeting was called on May 1 on the occasion of Field Secretary Jessup's visit to the Chapter. After two student papers on technical subjects were read, Mr. Jessup conducted a discussion on Society affairs. In the evening a dinner meeting was held for Mr. Jessup. The annual engineer's smoker, which was sponsored this year by the Chapter, was held with great success on May 27.

SOUTH DAKOTA STATE SCHOOL OF MINES

Illustrated lectures loaned by the Society were shown at several of the 1935–1936 meetings of the South Dakota State School of Mines Student Chapter. At one session Field Secretary Jessup discussed the aims and activities of that organization. Other speakers heard during the year were Earl D. Dake, professor of civil engineering at the South Dakota State School of Mines, and an engineer from the U. S. Soil Conservation Service.

STANFORD UNIVERSITY

The list of guest speakers present at the 1935–1936 meetings of the Stanford University Student Chapter included Edward Kotak, chief of the U. S. Forest Experiment Station; Field Secretary Jes-

STANFORD UNIVERSITY STUDENT CHAPTER

sup; Alfred J. Cleary, connected with the city administration of San Francisco; Henry J. Brunnier, designing and consulting structural engineer of San Francisco; and John B. Leonard, superintendent of the Bureau of Building Inspection of San Francisco. Short field trips were made during the year to local points of interest, and a long trip was taken to inspect the Metropolitan Aqueduct.

STATE COLLEGE OF WASHINGTON

Students presented a number of the papers on the technical programs of the State College of Washington Student Chapter during the year. On another occasion a joint dinner meeting of the Chapter and the University of Idaho Student Chapter was enjoyed. The Chapter displayed a detailed and interesting exhibit in the engineers' show held on April 24 and 25, and in the late spring it made a field trip to the Grand Coulee Dam. In all, there were 14 meetings with a total attendance of 380.

STATE UNIVERSITY OF IOWA

Students were largely responsible for the technical programs presented at the 1935–1936 meetings of the State University of Iowa Student Chapter, and their papers covered a variety of timely engineering topics. In all, there were 28 meetings, with a total attendance of 918. A number of these meetings were held jointly with local sessions of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. Some of the outside speakers who addressed such sessions were R. H. Miller, of the General Electric Company; James Aston, professor of metallurgy at Carnegie Institute of Technology; Henry E. Riggs, Vice-President of the Society; and Field Secretary Jessup. The Chapter took an active part in both the professional and social aspects of the annual engineers' week held by the university.

SWARTHMORE COLLEGE

Student papers were in order at most of the 1935–1936 meetings of the Swarthmore College Student Chapter. At five special meetings, however, the topic of vocational guidance was discussed by outside speakers who are well known in the field of industry, the list consisting of Thomas Taylor, of the U. S. Department of Commerce; Thomas B. McCabe, president of the Scott Paper Company; Emile du Pont, of the du Pont de Nemours Company, Wilmington, Del.; O. W. Eshbach, of the American Telephone and Telegraph Company; Howard L. Davis, of the New York Telephone Company; and Duane Van Horn, of the E. G. Budd Manufacturing Company, Philadelphia, Pa.

SYRACUSE UNIVERSITY

The Syracuse University Student Chapter reports 100 per cent enrolment of those eligible for membership in the 1935–1936 school year. The programs for the nine meetings held consisted of the showing of illustrated Society lectures and talks by outside speakers. Among these were Glenn D. Holmes, chief engineer of the Onondaga County Public Works Commission; D. J. Donovan, of the General Electric Company; R. R. Zipprodt, of the Portland Cement Association; K. C. Reynolds, assistant professor of hydraulics at the Massachusetts Institute of Technology; and Nelson F. Pitts, city engineer of Syracuse. Inspection trips were made to places of engineering interest in the vicinity of Syracuse as well as to the plant of the American Bridge Company at Elmira, N.Y.; the sewage disposal plants in the city of Rochester, N.Y.; and the power plants at Niagara Falls, N.Y.

TEXAS TECHNOLOGICAL COLLEGE

The 1935–1936 school year was an unusually active one for the Texas Technological College Student Chapter. There were ten meetings, with a total attendance of 197, students being responsible for the technical programs on most of these occasions. The outside speakers were Field Secretary Jessup and J. C. Carpenter, senior highway engineer for the U. S. Bureau of Public Roads. Members of the Chapter participated very actively in the annual engineering show, held on April 17 and 18, in which they demonstrated laboratory equipment and displayed engineering models.

TUFTS COLLEGE

The past school year proved unusually successful for the Tufts College Student Chapter. The highlight of the year was a two-day inspection trip in the spring that included points of engineering interest in Worcester, Springfield, Hartford, and Providence. Among the speakers at the technical sessions were Donald McLaughlin, professor of mining and geology at Harvard University, and Field Secretary Jessup. At one meeting a motion picture was shown through the courtesy of the Jeffrey Manufacturing Company. During the year members of the Chapter attended meetings of the Northeastern Section of the Society and of the Boston Society of Civil Engineers.

TULANE UNIVERSITY

The annual report of the Tulane University Student Chapter displays a record not only of 100 per cent membership during the past year but also of whole-hearted cooperation of the entire membership in the work of the Chapter. The 25 meetings held during the year attracted a total attendance of 1,259, responsibility for the technical programs at these sessions being largely in the hands of the students. An outside speaker who was greatly enjoyed was C. Glennon Melville, engineer in charge of the construction of the Mississippi River Bridge at New Orleans. Members of the Chapter attended the Fall Meeting of the Society at Birmingham, Ala., and they made inspection trips to many points of engineering interest. These included the recently completed Mississippi River spillway, the plant of the Jones and Laughlin Steel Company in New Orleans, and the U. S. Coast and Geodetic Survey ship, *Hydrographer*, which was surveying in the Gulf.

MEMBERS OF THE TULANE UNIVERSITY STUDENT CHAPTER INSPECT MINE OF THE TENNESSEE COAL, IRON AND RAILROAD COMPANY

UNION COLLEGE

The anual report of the Union College Student Chapter indicates that several interesting inspection trips supplemented the technical meetings occurring during the year. In January the senior-class members of the Chapter attended the Annual Meeting of the Society in New York and visited many points of engineering interest in and about the city. According to custom, the first meeting of the season was an informal get-together held at the farm of Warren Crosby Taylor, associate professor of civil engineering at the college. In all, there were ten meetings, with a total attendance of 200.

UNIVERSITY OF AKRON

The programs presented at the six meetings held by the University of Akron Student Chapter during the past year were in the hands of Student and guest speakers. Among the latter were the Hon. Harold H. Burton, mayor of Cleveland, and Field Secretary Jessup. Members of the Chapter attended the regional meeting of Local Sections at Zanesville, held on October 4, and the annual meeting of the Cleveland Section, which took place on January 14.

UNIVERSITY OF ALABAMA

Students, members of the faculty, and outside speakers cooperated to make the 13 meetings held by the University of Alabama Student Chapter during the past year successful. The student papers proved of unusual interest, as many timely engineering topics were presented. On the list of speakers were Donald C. A. du Plantier, assistant professor of civil engineering at the university; D. L. Chaney, of the Portland Cement Association; and Field Secretary Jessup. A number of engineering displays were exhibited in the St. Patrick's Day fair, and the Chapter organized the first Southern Student Chapter conference.

UNIVERSITY OF ARIZONA

During the past academic year the University of Arizona Student Chapter held nine meetings, with a total attendance of 223. Students contributed largely to the success of these occasions by presenting a variety of papers on current engineering subjects. On several occasions outside speakers were also heard, the list of these including Robert C. Baker, assistant director and chief engineer for the WPA in Arizona; Field Secretary Jessup; P. Martin, of the Tucson Water Department; Julian Powers, engineer of materials for the Arizona State Highway Department; and Raymond A. Hill, Director of the Society and consulting engineer of Los Angeles.

UNIVERSITY OF CALIFORNIA

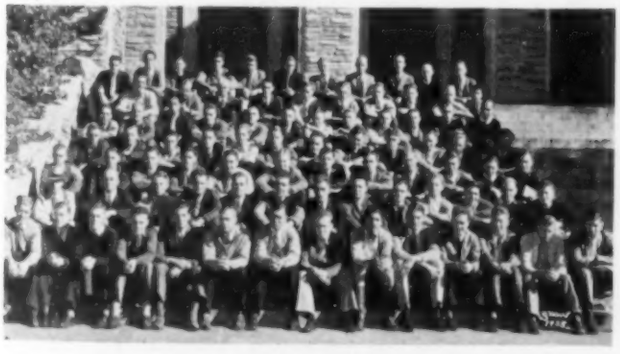
Monthly meetings were held by the University of California Student Chapter during the past year. Among the speakers on these occasions were Ralph A. Tudor, senior designing engineer of bridges for the California State Department of Public Works on the construction of the San Francisco–Oakland Bay Bridge; B. M. Brock, of the Columbia Steel Company; Richard Meyer, lieutenant, Corps of Engineers, U. S. Army; Fred C. Scoby, senior irrigation engineer, U. S. Bureau of Reclamation; A. N. Bent, vice-president of the American Concrete and Steel Pipe Company; and W. B. Boggs, chief engineer of the Broadway Low Level Tunnel Project. Inspection trips were made to the recently completed Park Street Bridge over the Oakland Bay estuary and to the San Francisco–Oakland Bay Bridge. A baseball game, picnic, and several banquets were also enjoyed.

UNIVERSITY OF CINCINNATI

The Student Chapter of the University of Cincinnati is proud of its 100 per cent enrolment of those eligible for membership. This was achieved in spite of the handicap under which the Chapter works of having half its members always away from the university on the cooperative plan. There were four general meetings, with a total attendance of 114. Among the speakers were Pusey Jones, consulting engineer of Cincinnati, whose address on the design of the Eggleston Avenue Viaduct aroused much interest. At the annual dinner meeting in March a four-reel picture of construction operations at the Grand Coulee Dam was shown by courtesy of the Jeffrey Manufacturing Company.

UNIVERSITY OF COLORADO

Student papers on a wide variety of timely engineering topics were presented at the 15 meetings held by the University of Colorado Student Chapter during the 1935–1936 academic year. Other



UNIVERSITY OF COLORADO STUDENT CHAPTER

speakers appearing on the technical programs were J. A. Elliot, of the U. S. Bureau of Public Roads; D. E. Kepner, manufacturers' representative for water works equipment in Denver; Field Secretary Jessup; and Herbert S. Crocker, Past-President of the Society.

UNIVERSITY OF DAYTON

During the past academic year the University of Dayton Student Chapter boasted 100 per cent enrolment. There were 11 meetings, at most of which the technical programs were in the hands of students who read interesting papers. At other sessions the speakers were Ernest O. Brown, assistant city civil engineer of Dayton; J. J. Chamberlain, Jr., architect and engineer of Dayton; and Field Secretary Jessup. The Society's illustrated lectures proved popular upon several occasions.

UNIVERSITY OF DELAWARE

The University of Delaware Student Chapter reports the completion of an unusually successful school year, the enrolment being 100 per cent. The list of speakers who addressed the meetings included E. O. Rhodes, of the Koppers Products Company; Hardy

LOUNGE ROOM OF THE UNIVERSITY OF DELAWARE STUDENT CHAPTER

Cross, professor of structural engineering at the University of Illinois; T. Alfred Fleming, of the National Board of Fire Underwriters; Field Secretary Jessup; Howard Ker, engineer in charge of the Chesapeake and Delaware Canal; and R. B. Young, testing engineer of the Hydro-electric Power Commission of Ontario, Canada. On April 28 the Chapter enjoyed an inspection trip to the Chesapeake and Delaware Canal. Early in the school year members of the Chapter converted part of their drafting room into a lounge, shown in the accompanying illustration. An extensive description of this lounge appeared in the June issue of CIVIL ENGINEERING in this department.

UNIVERSITY OF IDAHO

An interesting feature of the past year's work of the University of Idaho Student Chapter was the publication of *The Rock Crusher*, the official monthly magazine of the Chapter. Each month a new staff was appointed to publish the paper, thus giving an opportunity for many to gain valuable experience in the field of publication work. The Chapter also played an important rôle in the biennial engineers' show, and in April enjoyed an inspection trip that included several local engineering projects. At one of their four technical meetings a motion picture was shown through the courtesy of the Douglas Rothacker Company of New York City, and at another Ivan C. Crawford, Director of the Society, spoke.

UNIVERSITY OF KANSAS

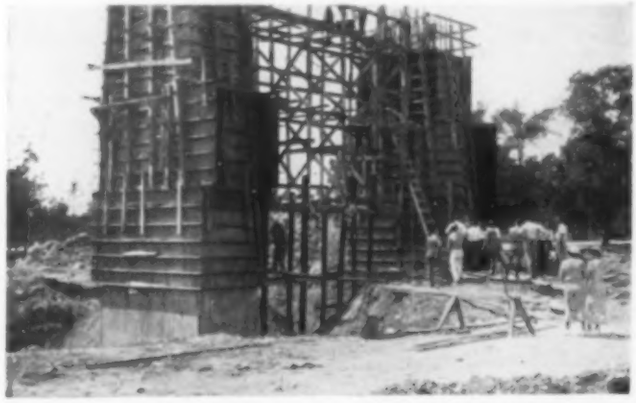
The list of guest speakers who appeared at 1935–1936 meetings of the University of Kansas Student Chapter included G. A. Hathaway, senior hydraulic engineer in the U. S. Engineer Office at Kansas City, Mo.; Henry E. Riggs, Vice-President of the Society; Clarence S. Jones, assistant engineer for the Missouri Valley Bridge and Iron Company; and C. L. Sadler, senior topographical engineer for the U. S. Geological Survey. On other occasions illustrated lectures were presented through the courtesy of the Johns-Manville Company and the Chicago Sanitary Drainage District.

UNIVERSITY OF KENTUCKY

There was 100 per cent enrolment of those eligible for membership in the University of Kentucky Student Chapter during the past year. Among the speakers heard at the 15 meetings were Field Secretary Jessup; C. G. Mellville, construction engineer for Modjeski, Masters, and Case; H. Graham, dean of the college of engineering at the university; James S. Watkins, contact member for the Chapter and consulting engineer of Lexington, Ky.; and Bryant Fleming and Charles P. Hoover. On several occasions the Society's illustrated lectures were enjoyed.

UNIVERSITY OF FLORIDA

Several motion pictures on current engineering subjects were shown at the 1935–1936 meetings of the University of Florida Student Chapter. At other sessions there were faculty and outside speakers—among them James L. Tryon, secretary of the graduate school of Massachusetts Institute of Technology; Donald S. Wallace, district engineer of the U. S. Geological Survey; Arthur N. Sollee, of the Duval County engineering staff; Capt. E. H. Levy, executive engineer of the Ocala Engineer District; and Brig.-Gen. Sumter Lowry. At the annual engineers' fair, held on May 8, the Chapter displayed a number of exhibits, and on April 23 it motored to Ocala, Fla., to inspect work now in progress on the Florida Cross-State Canal.



UNIVERSITY OF FLORIDA STUDENT CHAPTER INSPECTING BRIDGE PIER AT SANTOS, FLORIDA CROSS-STATE CANAL

UNIVERSITY OF MARYLAND

At the completion of its first year, the University of Maryland Student Chapter reports 100 per cent enrolment of those eligible for membership. At the inaugural meeting Daniel W. Mead and George T. Seabury, President and Secretary of the Society, respectively, were on the list of speakers. Among those at other sessions were Harry Hall, acting chief engineer of the Washington Suburban Sanitary District, and H. H. Allen, vice-president of the J. E. Greiner Company, of Baltimore. On May 22 a joint meeting of the Chapter, the Johns Hopkins University Student Chapter, and the Maryland Section of the Society was held at the Engineers' Club in Baltimore.

UNIVERSITY OF MICHIGAN

The University of Michigan Student Chapter reports the close of an interesting year, during which there were 20 meetings with a total attendance of 540. Members of the faculty and outside speakers were present in equal number at these gatherings to address the students. On the list of such speakers were W. S. Wolfe, head of the structural department of the engineering firm of Smith, Hinchman, and Grylls; L. C. Wilcoxen, assistant civil engineer for the city of Detroit; George T. Seabury, Secretary of the Society; and R. L. McNamee, consulting engineer of Ann Arbor. Several inspection trips were also enjoyed.

UNIVERSITY OF MINNESOTA

During the year the University of Minnesota Student Chapter held eight meetings, with an average attendance of 302. Among the speakers were Burton Ashley, who described geologic conditions in Tanganyika Province, South Africa; Clinton Morse, who spoke on working and living conditions in the Canal Zone; C. A. P. Turner, who discussed the economics of bridge-building and described his new design for long-span railroad bridges; and Field Secretary Jessup, whose subject was the history of the Society. In April the Chapter adopted a new set of by-laws to give the sophomores and juniors more voice in its government.

UNIVERSITY OF MISSOURI

Several of the Society's illustrated lectures were enjoyed by the University of Missouri Student Chapter during the past school year. On other occasions talks were given by Harry K. Rubey, professor of civil engineering at the university; Robert Wood, district engineer of the American Institute of Steel Construction; and Field Secretary Jessup. On November 23 the senior-class members of the Chapter were guests of the St. Louis Section of the Society at a banquet held in St. Louis.

UNIVERSITY OF NEBRASKA

The programs presented by the University of Nebraska Student Chapter during the past year were interesting and varied. Talks were given by students, members of the faculty, and outside speakers, and the Society's illustrated lectures were enjoyed on several occasions. At the last meeting of the year, which was held in conjunction with a meeting of the Nebraska Section, the speakers were Roy M. Green, president and manager of the Western Laboratories, Inc., of Lincoln; T. A. Leisen, Director of the Society; and John Latenser, Jr., state engineer for the PWA. Two especially interesting inspection trips were enjoyed—one a five-day trip through Nebraska and the other a ten-day trip that terminated at Hot Springs, Ark.

UNIVERSITY OF NEW HAMPSHIRE

There was 100 per cent enrolment in the University of New Hampshire Student Chapter during the past academic year. The technical programs presented on these occasions featured student papers—91 in all—which covered a variety of interesting and timely engineering topics. There were also special meetings, at which outside speakers were heard, the list including R. F. Zipprodt, of the Portland Cement Association; George Martin, consulting engineer for the Barrett Company of New York; E. P. Roberts, of the U. S. Coast and Geodetic Survey; and Field Secretary Jessup. In the spring a two-day inspection trip was made to places of engineering significance in and about Boston.

UNIVERSITY OF ILLINOIS

Sixteen meetings, with a total attendance of 1,594, marked the past year's activities of the University of Illinois Student Chapter. The Chapter's publication, *The Illini A. S. C. E.*, appeared in September and was used in the membership drive. Banner occasions were the smoker, which took place at the beginning of the school year, and the banquet, held at the end. Speakers at the meetings included Dean M. L. Enger and Prof. W. C. Huntington, of the University of Illinois; H. E. Riggs, Vice-President of the Society; Charles B. Burdick, Director of the Society; Robert Ridgway and A. J. Hammond, Past-Presidents of the Society; E. J. Noonan, consulting engineer of Chicago; Henry Penn, engineer for the American Institute of Steel Construction; Frank T. Sheets, consulting engineer for the Portland Cement Association; H. C. Boardman, research engineer for the Chicago Bridge and Iron Works; Dr. Herman Von Schrenk, consulting timber engineer; and Willard T. Chevalier, vice-president of the McGraw-Hill Publishing Company.

WILSON DAM VIEWED BY UNIVERSITY OF ILLINOIS STUDENT CHAPTER AS PART OF TWO-DAY INSPECTION TRIP

UNIVERSITY OF NEW MEXICO

There was 100 per cent enrolment in the University of New Mexico Student Chapter during the past year. Students presented papers at a number of the 25 meetings, and guest speakers were

heard on several occasions. The latter list included Paul S. Fox, public health engineer of New Mexico; Field Secretary Jessup; and Fred C. Scobey, senior irrigation engineer, U. S. Department of Agriculture. On October 11 and 12 the Chapter was host to the New Mexico Section and the New Mexico State College Student Chapter. The Chapter also participated in the annual engineer's open house, which was held in February.

University of Mississippi

Illustrated lectures furnished by the Society formed the nucleus of entertainment at the 1935–1936 meetings of the University of Mississippi Student Chapter. At other sessions students, members of the faculty, and outside speakers appeared on the technical pro-

MEMBERS OF THE UNIVERSITY OF MISSISSIPPI STUDENT CHAPTER

grams. On February 13 a two-reel motion picture was shown through the courtesy of the Indianapolis Water Supply Company. There was 100 per cent enrolment of those eligible for membership in the Chapter.

University of North Carolina (William Cain Engineering Society)

Biweekly meetings were held by the University of North Carolina Student Chapter during the past year. Talks by members of the faculty and the Society's illustrated lectures proved popular on these occasions. There were also several outside speakers—among them W. M. Piatt, contact member for the Chapter; Stanley H. Wright, consulting engineer of Chapel Hill, N.C.; D. S. Abell, president of the North Carolina Section of the Society; and Field Secretary Jessup. In the spring the Chapter joined local student branches of the other engineering societies in sponsoring the annual engineers' ball. There was 100 per cent enrolment in the Chapter during the year.

University of North Dakota

A partial report from the University of North Dakota Student Chapter indicates that several meetings were enjoyed during the past school year. Students and members of the faculty were the speakers on these occasions, and motion pictures were enjoyed at some of the sessions. Among the special events were a banquet, which took place on December 11, and a meeting in honor of Field Secretary Jessup, which took place on May 5.

University of Oklahoma (Stadia Club)

At the annual engineers' open house, held on St. Patrick's Day, the exhibits arranged by the University of Oklahoma Student Chapter were the best and most complete ever displayed by the Chapter. Among the speakers who appeared at the seven meetings were Field Secretary Jessup; Dudley H. Jones, superintendent of the state highway maintenance department; and N. E. Wolfard, state representative of the U. S. Coast and Geodetic Survey. On one occasion motion pictures were shown through the courtesy of the U. S. Bureau of Public Roads.

University of Pennsylvania

The University of Pennsylvania Student Chapter reports that, although its activities as an organized body have been limited during the past year because of difficulty in finding time for meetings, there has been a fine spirit of cooperation. There have been four meetings, which attracted a total attendance of 90. On January 20 the Chapter was host to Daniel W. Mead, President of the Society, and to all the Student Chapters in the vicinity. During the year the Chapter cooperated with local branches of the other engineering societies in sponsoring a motion picture and a dance. Because of the few meetings members of the Chapter were encouraged to attend the sessions of the Philadelphia Section.

University of Pittsburgh

The University of Pittsburgh boasted 100 per cent enrolment of those eligible for membership during the past school year. An imposing number of student papers were presented at the 30 meetings, and there was also a list of outside speakers. Included on this were the names of John Rice, chief engineer of the Allegheny County Authority; Henry Johnson, city engineer of Pittsburgh; M. J. Freeman, chief engineer of materials for the Tennessee Valley Authority; Leslie M. Johnson, director of the Pittsburgh Department of Public Works; J. S. Taylor, of the Pennsylvania Railroad Company; H. M. Kennon, managing engineer of the Pittsburgh Water Department; and Field Secretary Jessup.

University of South Carolina (Walter E. Rowe Student Chapter)

Weekly seminars, at which the students presented papers, were sponsored by the University of South Carolina Student Chapter during the past year. In addition to these programs, which proved interesting and helpful, the Chapter enjoyed a number of the Society's illustrated lectures as well as motion pictures that were shown through the courtesy of various industrial organizations. On April 8 Field Secretary Jessup visited the Chapter and gave a talk on the aims and activities of the Chapter. The social activities consisted of a banquet each semester.

University of Southern California

The University of Southern California Student Chapter reports 100 per cent enrolment during the past year. In all, there were 17 meetings, with a total attendance of 340. Some of the guest speakers present on these occasions were William Fox, contact member for the Chapter and chief engineer of the Los Angeles County Department of Building; Field Secretary Jessup; and Carl E. Arnold, chief deputy county surveyor. On one occasion the Chapter was host to the Los Angeles Section.

University of Texas

The 1935–1936 meetings of the University of Texas Student Chapter were interesting and varied, the programs being divided between the presentation of student papers, talks by outside speakers, and the showing of the Society's illustrated lectures. Among the outside speakers were Guiton Morgan, city manager of Austin, Tex.; Field Secretary Jessup; Henry E. Riggs, Vice-President of the Society; V. M. Ehlers, state sanitary engineer of Texas; H. S. Gillette, of the U. S. Bureau of Public Roads; and Cody Wells, H. C. Porter, and T. C. Mitchell, of the Texas State Highway Department. Inspection trips were made to San Antonio and Dallas, and the Chapter participated in the annual engineers' power show.

University of Utah

The University of Utah Student Chapter had a successful and active year. There were five inspection trips—to the Pine View Dam, the Cutler Power Plant, the mills of the Utah Copper Company, the new steam power plant of the Utah Power and Light Company, and the Deer Creek Dam site. The Chapter made a group excursion to the state fair and participated in engineer's week by cooperating with other groups in presenting many displays. At six of the twelve regular meetings of the Chapter, the Society's lantern lectures were used. The Chapter's strictly social events consisted of several dances and stag parties.

University of Virginia

The University of Virginia Student Chapter reports the close of an unusually successful school year. The season was inaugurated with a smoker, at which the speakers were John L. Newcomb, president of the university; Walter S. Rodman, dean of the engineering department; Thomas H. Evans, assistant professor of civil engineering; and Seth Burnley, contact member. Another meeting that proved of interest was addressed by C. H. Birdseye,

chief of the Division of Printing and Engraving of the U. S. Geological Survey. A number of the members of the Chapter attended the Student Chapter conference held at Virginia Polytechnic Institute, and three of their papers were presented as part of the program.

UNIVERSITY OF WASHINGTON

During the 1935–1936 school year, the University of Washington Student Chapter held 14 meetings, with a total attendance of 395, in addition to three field trips. Among the lectures enjoyed were those of R. G. Tyler, dean of the college of engineering; by B. M. Brock, of the Columbia Steel Company, on rolling steel sections; by W. D. Shannon, engineer of Seattle; by E. French Chase, on the Green Lake dredging project; and by E. B. Crane, principal assistant engineer of the Chicago, Minneapolis, St. Paul and Pacific Railroad. At the engineers' open house in April, the Chapter sponsored the civil engineering exhibit which was placed third in the judging. The last meeting of the year was a joint dinner with the Seattle Section.

UNIVERSITY OF WISCONSIN

Among the speakers who addressed the University of Wisconsin Student Chapter during the 1935–1936 school year were James L. Ferebee, Society Director and chief engineer of the Milwaukee Sewerage Commission; L. F. Van Hagen, professor of railway engineering at the university; Prof. G. L. Larson of the university; Daniel W. Mead, President of the Society; and Field Secretary Jessup. The Chapter held six meetings at which the total attendance was 247.

UNIVERSITY OF WYOMING

Biweekly meetings were held by the University of Wyoming Student Chapter during the past year. At these sessions talks were given by Ned Williams, assistant bridge engineer for the Wyoming State Highway Department; Nels Swenson, president of the Swenson Construction Company; Elmer K. Nelson, contact member for the Chapter and city engineer of Laramie, Wyo., and many others. There were two special meetings—one called on April 29 in honor of Field Secretary Jessup, and the other a joint meeting with a session of the Wyoming Engineering Society. A seven-day inspection trip that included a visit to the Fort Peck Project at Fort Peck, Mont., was enjoyed by the members of the Chapter, as was the annual engineers' open house.

UTAH STATE AGRICULTURAL COLLEGE

The 1935–1936 activities of the Utah State Agricultural College Student Chapter included nine regular meetings (with a total attendance of 435), several minor and one major field trip, and several social events. The major field trip, conducted under the direction

UTAH STATE AGRICULTURAL COLLEGE STUDENT CHAPTER

of Prof. G. D. Clyde, was to the Pine View Dam, and proved most interesting and valuable. In addition minor field trips were enjoyed by each class. The engineers' day celebration, which was held on St. Patrick's Day, included a banquet and dance.

VIRGINIA MILITARY INSTITUTE

As one of the main objectives of the work of the Virginia Military Institute Student Chapter is to teach the members to speak in public, a number of programs of cadet speakers were arranged. On October 12 the Chapter was host to the Virginia Section, for its annual fall meeting. Among the speakers were W. R. Glidden, of the Virginia State Highway Department, and A. E. Crockett, of the Jones Laughlin Steel Corporation. In December a sound motion picture of the TVA project was shown. Among the outside speakers heard during the year were E. M. Hastings, chief engineer of the Richmond, Fredericksburg and Potomac Railroad, contact member; and W. F. Kellerman, of the Division of Tests, U. S. Bureau of Public Roads.

VIRGINIA POLYTECHNIC INSTITUTE

The Virginia Polytechnic Institute Student Chapter reports the close of a successful academic year. The Society's illustrated lectures were shown at some of the meetings, and at others talks were given by students, members of the faculty, and outside speakers. The Chapter sponsored an engineers' masquerade and ball, and on April 3 and 4 it was host to the regional Student Chapter convention. In all, there were 12 meetings, which attracted a total attendance of 460.

WASHINGTON AND LEE UNIVERSITY (CUSTIS LEE ENGINEERING SOCIETY

Incomplete reports from the Washington and Lee University Student Chapter indicate that several meetings were enjoyed during the past school year. The speakers at most of these sessions were members of the Chapter. The first meeting of the year was addressed by J. A. Veech, instructor in engineering at the university, who discussed the need for a Student Chapter.

WASHINGTON UNIVERSITY (COLLIMATION CLUB)

The Washington University Student Chapter has completed an active year, in which it had 100 per cent enrolment of those eligible for membership. Among the speakers at the 16 meetings were W. W. Horner, consulting engineer of St. Louis; F. C. Woermann, president and treasurer of the Woermann Construction Company, of St. Louis; and Professor Cullen, of the Washington University Law School. The most important event of the year was engineers' day, in which the Chapter entered a large number of exhibits that received wide commendation. Another interesting occasion was a combination picnic and inspection trip held on May 15.

WEST VIRGINIA UNIVERSITY

The past academic year was unusually successful for the West Virginia University Student Chapter, which had a 100 per cent enrolment. Thirty meetings were held, the programs on these occasions being almost entirely in the hands of students. On one occasion the Chapter heard Field Secretary Jessup, and on May 15 it took part in the biennial engineering show. In conjunction with local branches of the other engineering societies, the Chapter made two inspection trips to the Tygart River Dam at Grafton, W.Va.

WORCESTER POLYTECHNIC INSTITUTE

During the past year the Worcester Polytechnic Institute Student Chapter held five meetings, which were attended by a total of 155. The list of outside speakers heard during the year included Field Secretary Jessup, who spoke on interesting phases of his work for the Society; Lester W. West, contact member for the Chapter, whose topic was the advantages of membership in the Society; and Albert E. Kleinert, assistant structural engineer for the Massachusetts Department of Public Works. On another occasion motion pictures were shown through the courtesy of the Jeffrey Manufacturing Company and the American Steel and Wire Company.

YALE UNIVERSITY

The Yale University Student Chapter boasted 100 per cent enrolment during the 1935–1936 school year. Several informal social meetings, held at faculty homes, were enjoyed during the year, and in January members of the Chapter were dinner guests of the Connecticut Section of the Society. Among the outside speakers who appeared at the technical sessions were Clifford A. Betts, engineer of dams for the U. S. Forest Service, and W. J. D. Reed-Lewis, engineer for the Lawrence Portland Cement Company. On February 21 and 22 the Chapter was in charge of an engineering exhibit, which took the place of the usual large public lecture.

ITEMS OF INTEREST

Engineering Events in Brief

CIVIL ENGINEERING FOR OCTOBER

PAPERS DELIVERED at the Sixty-sixth Annual Convention of the Society, held in Portland, Ore., July 15–18, 1936, will be abstracted, in as complete a form as space permits, in the October number of CIVIL ENGINEERING. Over two dozen papers were delivered in all, covering various features of Society work as well as the programs of 7 Technical Divisions.

Dr. Mead's noteworthy address on the engineer and his code was printed in full in the August issue. The next paper presented at the Convention described Oregon history and geology and formed a background for later papers on local problems. Eight activities of the Society were reported, including the subjects of registration, salary studies, engineering fees, reemployment of engineers, professional development, national relations, education of the public, and Society aims and activities.

Construction features of the Grand Coulee, Fort Peck, and Bonneville dams, as well as navigation improvements on the Columbia River, were described in a series of five addresses. Important problems encountered by the Oregon State Highway Department, including the design and construction of five new bridges on the coast highway, formed the subject matter for a symposium of three papers. Two addresses on irrigation in the North Pacific district and near Grand Coulee were followed by one on sanitary protection of the Portland water supply, another on mosquito control, and three on the Oregon stream-cleansing program.

Those who attended the Portland Convention are convinced that it presented a well-rounded program of superior quality. It is hoped that abstracts of the technical papers will convey the resulting inspiration in some degree to members who were unable to be present.

Third World Power Conference to Convene September 7

MORE THAN 700 distinguished foreigners, representing 50 nations, and some 2,500 Americans, will attend the sessions of the Third World Power Conference which opens in Washington, D.C., on September 7. During the meetings all phases of power—its sources, uses, distribution, and conservation—will be discussed under the general subject of "The National Power Economy."

All sides of the questions growing up around public and private power policies will be included. The conference will seek to point the way to a wider and wiser distribution and use of power.

In its form of organization, the World Power Conference is a federation of national committees of some 50 countries. The meetings this year are the first to be held in the United States. They are being sponsored and financed jointly by the private electrical industry and the federal government. Several tours to large industrial centers of the country will be conducted both before and after the Washington sessions. The International Commission on Large Dams was set up under the auspices of the conference several years ago.

Positions Open in Army Engineer Corps

THE OFFICE of the Chief of Engineers, U. S. Army, Washington, D.C., has announced an examination for appointment of second lieutenants in the Corps of Engineers, U. S. Army. This is to provide the first increment in increase in officer strength of the Corps which was recently authorized by Congress. The number of appointments will be limited to eighteen. Applicants must be citizens who will be between the ages of 21 and 30 on February 1, 1937. Applications for examination must be submitted to the Corps area commander of the Corps area in which the applicant is resident in time to be received not later than September 15, 1936. The application must be on a special form designated as War Department Form No. 62, copies of which may be secured from any Corps area headquarters or at any military post or station.

Addresses of Corps area commanders are as follows:

CORPS AREA	ADDRESS
First	Army Base, Boston 9, Mass.
Second	Fort Jay, Governors Island, N.Y.
Third	U. S. Post Office and Court House, Baltimore, Md.
Fourth	Old Post Office Building, Atlanta, Ga.
Fifth	Fort Hayes, Columbus, Ohio
Sixth	948 New Post Office Building, Chicago, Ill.
Seventh	Federal Building, 15th and Dodge Streets, Omaha, Nebr.
Eighth	Fort Sam Houston, Texas
Ninth	Presidio of San Francisco, Calif.

This is an opportunity for young men with suitable qualifications to try out for a commission in the regular army. In announcing the examinations, Brigadier General George B. Pillsbury, M. Am. Soc. C.E., acting chief of engineers, states: "These examinations afford an unusual opportunity for appointment to a service especially attractive to young men of exceptional qualifications and ambition."

Wise and Otherwise

PROFESSOR ABERCROMBIE'S analytical turn of mind occasionally stands him in good stead. Not long ago he was taking a cruise down the bay on a small power boat accompanied by a friend. The boat had a chart but no compass. Unfortunately they lost their sense of direction in a heavy fog and were overtaken by night. Guarding the somewhat rugged coast was a lighthouse which showed revolving red and white lights. The white light, the Professor knew, made a full circuit through north, east, south, and west in two minutes, while the red traveled in the same direction at twice this rate. He also knew that whenever the white light shone toward the north, the red did the same.

Professor Abercrombie immediately dropped anchor and took out his watch. He noted that the red light faced him once, then again one minute later. Twenty-one seconds later the white light came. With this data he quickly determined his bearing from the lighthouse and fixed his course for the shore. What was the Professor's bearing?

Referring to the problem of the monkey and the leopard, which appeared in the August number of CIVIL ENGINEERING, Professor Abercrombie puts the critical question thus: "What is the monkey's rate of climb with relation to the ground?" Since the cocoanuts on the opposite end of the vine are exactly equal in weight to the monkey, and since the weight of the vine and the friction between the vine and overhead branch are assumed negligible, it follows by the laws of physics that the weight must always be at the same height above the ground as the monkey. In other words, while the vine passes through the monkey's paws at the rate of 4 ft per sec, his rate of climb with relation to the ground is only 2 ft per sec. Now, when the leopard arrives at the vine 3 seconds later than the monkey, the latter is 6 ft off the ground. The leopard leaps exactly 6 ft high, but during the fraction of a second that it takes him to rise through the air, the monkey has climbed out of his reach. Two seconds later the leopard can jump 11 ft high after the monkey. As the monkey is at that time only 10 feet up, the leopard will succeed in catching the simian by so doing. Should the leopard elect to go after the cocoanuts, however, in the $2^1/_2$ sec required for the leap the cocoanuts will have risen to 11 feet plus a small fraction, and so be out of his reach.

Suggestions for other problems for Professor Abercrombie's column, accompanied by solutions, may be addressed to the editor. Solutions should be sent in separate enclosed envelopes.

Erecting the Harlem River Lift Span

An Integral Part of New York City's Triborough Bridge

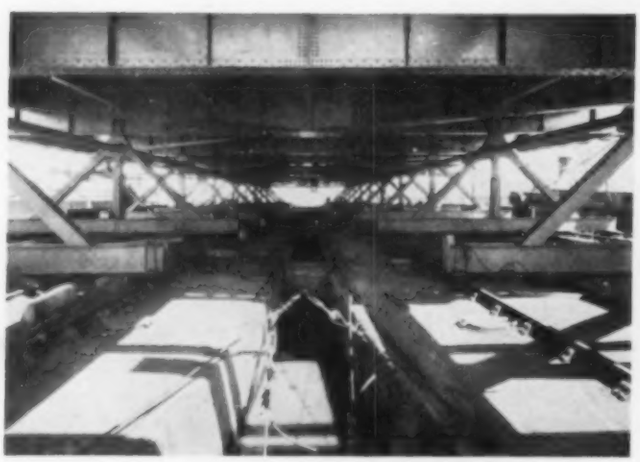
On this page the story of erecting the Harlem River lift span is told pictorially. The span was assembled on barges, floated into position between towers, and raised to pier level, where end panels were erected and connections to counterweights made. Roadways and sidewalks were installed with the span at full height.

FIRST—PLACING SHEAVE HOUSING ON RANDALL'S ISLAND TOWER

At Each End of the Lifting Girder the Plow-Steel Wire Ropes Are Secured to Short Box Girders in Four Groups of Six Ropes Each

FOURTH—LIFT SPAN WEIGHT WAS TRANSFERRED TO THE ROPES BY THE FALLING TIDE, AIDED BY PUMPING WATER INTO THE FLOATS AND JACKING DOWN THE COUNTERWEIGHTS

THIRD—HARLEM LIFT SPAN COMPLETELY ASSEMBLED ON FLOATS, WITH TEMPORARY END-TRUSS DIAGONALS DESIGNED TO CLEAR PIERS WHEN FLOATING INTO PLACE



SECOND—THE LIFT SPAN WAS BUILT UP ON A-FRAME SUPPORTS

View Between Floats Showing Under Side of Floor System

FIFTH—FLOOR PLATES WERE SHOP-WELDED TO THE SUBSTRINGERS

Bronx Kills Floor Construction Similar to Harlem Design

Arc-Welding Steps In

By WILLIAM W. STARKE, JR.
MEMBER OF THE UNIVERSITY OF VIRGINIA STUDENT CHAPTER, CHARLOTTESVILLE, VA.

No small part of the value of the Student Chapters lies in the training they provide in the preparation of technical papers. Some Chapters depend almost entirely on student papers for their regular sessions, and most regional student meetings accord them a prominent place on the program. The following article, typical of the work being done in these groups, is abstracted from a paper prepared by a student and presented on April 4 at the joint meeting of Student Chapters at Virginia Polytechnic Institute.

EVER SINCE the introduction of steel as a material of construction, the engineer has been attempting to discover more efficient ways of connecting members made of it. At first, connections were secured by running a steel pin through the ends that were to be held together. Thus great strength against tensile or compressive forces was obtained, but rigidity had to be sacrificed.

In the latter part of the nineteenth century riveted joints were introduced. When, by 1900, the art of riveting was well developed, engineers believed they had found the answer to their problem, because they could develop great strength and also great rigidity.

It was not until after the World War that anyone thought of utilizing welding for large-scale construction. Its advantages were immediately apparent, though some were reluctant to use it because it was new and little understood.

At this point, some of the larger manufacturers of electrical equipment began to experiment with welding. They helped to familiarize engineers with the simple process. They explained that welding was not difficult or mysterious. They showed that in order to weld all that was necessary was to bring together the edges of the parts to be welded, and fuse them. Where needed, extra steel could be added to the joint from a small steel rod.

The heat required to fuse the metal was developed by an electric arc. Three types of arc were tried: the metallic arc, the carbon arc, and the atomic-hydrogen arc. The latter two, however, did not lend themselves readily to the work for the electrode had to be held in one hand and the filler rod, which plays a large part in joint construction, had to be held in the other. In metallic-arc welding, the filler rod itself is the electrode which the operator holds, and therefore he has a free hand. The circuit is completed by simply attaching to the steel beam a return wire to the generator. Whereas in the other cases the placement of the filler steel was dependent upon gravity, in this case the steel particles flow along the arc with the current, enabling the operator to weld from underneath.

By 1926 these companies were ready to make demonstration tests. As had been expected, the process was noiseless. Moreover it was definitely shown that the welded joint was as strong as, if not stronger than, the old riveted joint, and since few holes had to be punched in the beam, the same strength was developed in a smaller beam.

The electric companies went further and constructed buildings with the new joint. They found these new buildings to be entirely up to the standards of the old, with the use of less steel and labor. One welder could do as much work as a riveting gang of four men. Then too, the joints were much better protected against corrosion because they were airtight and watertight, and could be painted more easily than riveted joints. Finally, the steel used at the joint was about 15 per cent of the weight of the rivets required for the same strength and rigidity.

Constructors have not yet accepted the new joint as the only one to be used, because they want to be absolutely certain. The outstanding defects they find are first, that taking all items into account, welded buildings cost more, and second, that the welds are sometimes imperfect. The excess cost, however, is entailed by the purchase of welding machinery for the job, and by the unnecessary time put in by the draftsmen in trying to get the best designs. But welding machinery, once purchased, can be used on a hundred jobs, and the extra time required in design is due to inexperience and will not occur when the process has been perfected.

As for imperfections, practically all welds can be made sound by demanding expert welders and by covering the filler rods with a coating which prevents air holes in the weld. The fact that many cities have recognized welding in their building codes shows that they are convinced of its safety. So it can be said that a new era has come in the use of steel in construction. The engineer has a perfected tool to aid him in construction.

© *California Toll Bridge Authority Through Courtesy of C. S. Proctor, M. Am. Soc. C.E.*

A RECENT PICTURE OF THE SAN FRANCISCO–OAKLAND BAY BRIDGE

Completion of this $77,000,000 Structure Is Scheduled for November 1, 1936. Work Was Begun in July 1933. This View Is Taken Looking East from San Francisco, with Yerba Buena Island at the Left and the City of Oakland in the Background

Government and the Engineer

By RICHARD H. LUDEMAN
JUNIOR AMERICAN SOCIETY OF CIVIL ENGINEERS
DESIGNER, FOUNDATION DEPARTMENT, M. W. KELLOGG COMPANY, NEW YORK, N.Y.

As announced in July, first place in the 1936 public speaking contest sponsored by the Junior Branch of the Metropolitan Section was awarded to Richard H. Ludeman. Because of its general interest and appeal his address, somewhat abbreviated, is reproduced here. Mr. Ludeman credits a pamphlet entitled "The Engineer's Duty as a Citizen," by Roy V. Wright, former President of the American Society of Mechanical Engineers, for suggesting some of the ideas set forth in his remarks.

MODERN industry has conferred many benefits upon us: Lessened human toil, shorter working hours, greater comfort, and marked educational and recreational advantages. But with these benefits have come many great evils—social and economic problems that demand a solution.

The engineer must be given a large part of the credit for the development of the modern world. Likewise, he must acknowledge a large part of the responsibility for attacking and solving its problems.

For several reasons the engineer is specially qualified to undertake this great task. The tradition of his profession includes an interest in the public welfare. In his daily work he deals with many of the common denominators of these problems—power units, man hours, dollars. Finally as an applied scientist he is devoted to truth, wherever it may lead. It is most important that young engineers achieve an orientation from which to face these great public tasks, and that they steadily train and equip themselves to perform them.

There are five courses of action open to the young engineer who is ambitious to become a positive factor in public affairs. First, he should participate actively in the work of the Society as it relates to public affairs. Second, he should undertake an individual study of history, economics, politics, and government. Third, he may make a detailed study of his own locality—its people, its industries, government, and municipal facilities. He should find out how the taxes are spent, and what improvements are needed and justified. Fourth, he may enter into the work of some local organization which is endeavoring to improve government and municipal facilities. Fifth, he should join a political party, if the nature of his work permits, and learn the inner operations of the political machine, while working with the better element to get the best available men in the party nominated and elected.

Today there is the greatest need for aggressive political action by responsible people. Ignorance and indifference betray us into the hands of those politicians who are dishonest and incompetent. Good management in government is becoming increasingly an essential part of the business of life.

Government and engineering are becoming steadily more closely interrelated. Today more than ever before governmental agencies are entering into engineering projects directly. Moreover, as industry and commerce become more intricate in their structure and operation, government must of necessity undertake their regulation to an increasing extent. From the long-range point of view, today is in reality the day of great opportunity for the young engineer who is interested in public affairs. But he must choose his path early. On the one hand, lies the road that the out-and-out technician will follow; on the other, lies the ascending path of the greater engineer, the leader of men as well as the master of the forces and materials of nature. Those who form the vanguard up this road will mount to greater power and to greater opportunities for service. They and their followers will provide a surer guiding hand in the affairs of town, state, and nation.

A Reading Club for Student Engineers

A NON-TECHNICAL reading club for students of engineering has been in successful operation for two years at the University of Virginia. It was formed at the suggestion of J. L. Vaughan, instructor in engineering English, for the purpose of getting the technical students acquainted with general contemporary literature.

Under the leadership of W. L. Davis, treasurer in 1935 of the local Student Chapter of the Society, several students and faculty members contributed 50 cents apiece to purchase a few current books—fiction and non-fiction—that were chosen by popular vote. The Department of Engineering also contributed a small fund for purchases, with the understanding that the club would turn books of equivalent value over to the engineering library at the end of the year. With the help of this fund, and donations and loans of choice volumes by the faculty members, the club soon built up an excellent, readable library.

It was decided the following fall that some definite organization was necessary for continuity and efficiency. Accordingly, the members drew up a constitution and elected men for the offices of president, secretary-treasurer, and assistant secretary-treasurer. Only one meeting a year is necessary, for the officers carry on all the work of operating the club. A book-purchasing committee receives from the members at any time suggestions and requests for books to be purchased. Three times a year this committee prepares polls made up of these requests and passes them out to the members, who vote for ten books on each poll. The ten books receiving the highest number of votes are then bought through the university library.

The following titles are typical of those making up the present collection: *So Red the Rose*, by Young; *Seven Pillars of Wisdom*, by Lawrence; *Mutiny on the Bounty*, by Nordhoff and Hall; *Confessions of a Scientist*, by Ditmars; *Etiquette*, by Emily Post; *Revolt on the Campus*, by Weschler. The fact that these types of books are eagerly read by the club members shows that they are keeping up with the non-technical world and are doing their bit to disprove the theory that engineers are professional ascetics.

The information in this article was supplied by Howard B. Edwards, engineering student at the University of Virginia.

Brief Notes from Here and There

THE Highway Research Board of the National Research Council will hold its sixteenth annual meeting in Washington, D.C., November 18–20, 1936. This schedule is some weeks ahead of that in past years. Details of the program are not available at this time.

* * * *

A COURSE in analysis of continuous frames will be given by Hardy Cross, M. Am. Soc. C.E., in the rooms of the Western Society of Engineers, Chicago, on Saturday afternoons beginning September 26. The course is under the auspices of the Western Society and other engineering societies and colleges of the Chicago region. The work may be taken for credit or not, as the student chooses. Full information can be obtained from the Extension Division of the University of Illinois, at Champaign, or from the Western Society of Engineers at Chicago. The fee is $25.

* * * *

CHAMBERS OF COMMERCE should develop their relationships with local construction interests and problems, says a pamphlet recently published by the Chamber of Commerce of the United States. To this end it advocates that each local chamber set up a representative and active construction and city development committee, including in its personnel an architect, an engineer, a general contractor, and a manufacturer of building equipment or materials, as well as other persons designated as "non-industry personnel." Suggested activities include encouragement of the use of private engineers experienced in design and supervision in their particular fields; education of the public as to the value of prequalification requirements for contractors; and assistance to industry in fighting the encroachment of day labor—that is, construction work that the public agency does itself rather than by contract. The pamphlet was prepared by the construction and civic development department committee of the Chamber. Of the 11 members of that committee, the following 6 are members of the Society: A. P. Greensfelder (chairman), Harland Bartholomew, Carey H. Brown, John F. Coleman, A. J. McKenzie, and Stephen F. Voorhees.

NEWS OF ENGINEERS

Personal Items About Society Members

SAMUEL SHULITS, formerly engaged on the Colorado River silt problem in the Denver office of the U. S. Bureau of Reclamation, has been appointed assistant professor of mechanics and hydraulics at the Colorado School of Mines. His new duties will begin September 1, 1936.

S. S. WILLIAMS is now employed as a junior engineer in the hydraulics division of the U. S. Engineer Office at Huntington, W.Va.

C. KEN WEIDNER has entered the employ of the University of Washington in the capacity of assistant superintendent of buildings and grounds.

JOHN C. PRIOR was recently appointed a member of the Columbus, Ohio, City Planning Commission to fill a vacancy caused by the resignation of F. H. ENO.

JOSIAH R. JOHNSTON, formerly a special agent in the division of investigation of the Public Works Administration at Portland, Ore., is now assistant superintendent of construction and repair in the Department of Public Works of St. Paul, Minn.

WALLACE A. THOMAS has resigned as city engineer of Ferguson, Mo., to accept a position with the A. D. Gates Construction Company in St. Louis, Mo.

ROBERT JOHN SMITH has become resident engineer for the Michigan State Building Department on the construction of a tuberculosis sanitarium at Gaylord, Mich.

JOSEPH GRUENBAUM recently received a PWA appointment to the post of resident engineer inspector on various hospital projects for the city of New York. Previously he was engineer inspector of pier and dock construction for the Department of Docks of New York.

RUSSELL B. NEAL is now employed in the engineering and casualty department of Marsh and McLennan, Inc., of Chicago, Ill.

FRANK A. RUSSELL, professor of civil engineering at the University of Kansas, has been appointed chairman of an executive committee to function pending the selection of a successor to the late Dean G. C. Shaad.

JAMES L. CHERRY was recently appointed to the staff of the Pennsylvania State College as an instructor of architectural engineering.

H. LEE NELSON, formerly with Jensen Bowen, and Farrell, of Ann Arbor, Mich., is now employed by Ayres, Lewis, Norris, and May, consulting civil and electrical engineers of the same city.

RAYMOND J. ROSENBERGER has been appointed a delegate to represent the National County Roads Planning Commission at the Third World Power Conference and Second Congress on Large Dams to be held in Washington, D.C.

GUY W. CARLTON, with L. A. Harding, has established the Harding Carlton Corporation, an engineering and construction firm, in Buffalo, N.Y., to succeed the L. A. Harding Construction Company. For the past seventeen years Mr. Carlton has been vice-president and director of the John W. Cowper Company, Inc., of the same city.

LAWRENCE H. HUNT is now field engineer on new construction for the Inland Steel Company, East Chicago, Ind. Prior to that he was in the bridge department of the Nebraska State Department of Roads and Irrigation.

KAY N. G. SAURBREY has been appointed an engineer-examiner for the Public Works Administration in Washington, D.C.

SPENCER B. LANE is resident engineer in the Bridge department of the California Division of Highways, with headquarters at Stockton, Calif.

JOHNSON L. FORBIS, former assistant district engineer for the 7th WPA District of Oklahoma, is now connected with the Oklahoma State Highway Department. He is located at Bristow, Okla.

GEORGE R. RICH has been transferred from the U. S. Engineer Office at Eastport, Me., to that in Boston, Mass., where he will serve as hydraulic engineer on flood-control work. At Eastport, Mr. Rich acted in a similar capacity on the Passamaquoddy tidal power project.

ANTHONY P. LABATE is at present employed as test engineer for the Cameron Pump Division of the Ingersoll-Rand Company at Phillipsburg, N.J. Previously he was an engineer in the Forestry Service at Easton, Pa.

EDWIN P. WILLIAMSON, who has been serving as dredging inspector for the Corps of Engineers, U. S. Army, in Chicago, Ill., was recently appointed inspector in the U. S. Engineer Office at Peoria, Ill.

WILLIAM POPPER, formerly with Morrison-Utah-Winston, of Yuma, Ariz., is now junior bridge designing engineer for the state of California, with headquarters in Sacramento, Calif.

W. T. IVEY was recently transferred from the Birmingham, Ala., office of the Peoples Water and Gas Company, to Meridian, Miss., where he is serving as general superintendent of the Mississippi division of the same organization.

CHARLES BAUGHN is now connected with Lee C. Moore and Company, of Tulsa, Okla., in the capacity of engineering draftsman. Previously he was a draftsman for the Arkansas State Highway Commission.

J. WADE SWITZER, formerly resident work relief engineer for the Emergency Relief Administration at Logan, Iowa, is now junior engineer for the Chicago Bridge and Iron Works in Chicago.

E. J. AFFELDT, who has been employed by the Grasselli Chemical Company, of Cleveland, Ohio, a subsidiary of the E. I. du Pont de Nemours and Company, has been transferred to the offices of the parent company at Wilmington, Del.

FRANKLIN D. HOWELL, consulting engineer of Los Angeles, Calif., has been appointed a member of the Board of Water and Power Commissioners of Los Angeles.

O. D. STINSON, previously senior draftsman with the North Carolina State Highway Commission, has become connected with the State Highway Board of Georgia as an assistant resident engineer on construction.

THEODORE T. KNAPPEN, formerly chief engineer of the Zanesville Engineer District, has been transferred to the North Atlantic Division of the U. S. Engineer Office in New York City.

DONALD T. JORDAN, who has been employed on the construction of the San Francisco–Oakland Bay Bridge, is now in the Gary, Ind., office of the American Bridge Company.

F. E. CULVERN, formerly with the U. S. General Land Office at Aberdeen, Md., has accepted a position as bridge detailer with the State Highway Board of Georgia.

LLOYD S. DYSLAND is now employed by the consulting engineering firm of Consoer, Townsend, and Quinlan, of Chicago, Ill.

JOHN S. KENNOY has been promoted from the position of concrete inspector for the Tennessee Valley Authority at Wheeler Dam, Sheffield, Ala., to that of assistant concrete technician on the Guntersville Dam project of the same organization, at Huntsville, Ala.

SOLON HERZIG was recently appointed resident engineer inspector for the PWA on the construction of a tuberculosis sanitarium near Orlando, Fla.

HUGH J. CASEY, captain, Corps of Engineers, U. S. Army, has been transferred from the U. S. Engineer Office at Eastport, Me., to the Boston district office of the U. S. Engineers.

CYRUS C. BABB, consulting hydraulic engineer of Granite Falls, N.C., has been appointed associate water consultant for the third drainage district of the National Resources Committee.

MARSH F. BEALL has resigned his position with the Timken Roller Bearing Company of Canton, Ohio, to enter the Denver office of the U. S. Bureau of Reclamation.

GLEN E. LOGAN, formerly with the U. S. Coast and Geodetic Survey, at Oakland, Calif., is now chief of party for the U. S. Army Engineers at San Francisco, Calif.

JOHN N. FINLAYSON, formerly professor of civil engineering at the University of Manitoba, has been appointed dean of the faculty of applied science and head of the department of civil engineering at the University of British Columbia.

ASA H. MORRILL has been appointed chief engineer of the Boston and Maine and the Maine Central railroads, with headquarters in Portland, Me. Previously Mr. Morrill was assistant chief engineer.

FREDERICK C. STAUFFEN, formerly plant engineer and later general superintendent of the Union Shipbuilding Company, Baltimore, Md., has purchased the Winchester Manufacturing Company, Inc., of which he is now president and treasurer. This company manufactures pharmaceutical specialties.

FRED R. MCCOMB is now a draftsman for the Sinclair Refining Company, of East Chicago, Ind. Previously he was in the Denver office of the U. S. Bureau of Reclamation.

ROBERT N. MOFFETT, who has been in the employ of the Philadelphia and Reading Coal and Iron Company, at Pottsville, Pa., is now tool designer for the By-Products Steel Corporation at Coatesville, Pa.

E. T. JENSEN was recently granted a leave of absence from the bridge department of the Iowa State Highway Commission to serve as civil engineer of design for the Iowa State Park Service under the Conservation Commission. His headquarters are still in Ames, Iowa.

F. B. CAMPBELL, associate engineer, U. S. Soil Conservation Service, has been transferred from Statesville, N.C., to Spartanburg, S.C., where he will have charge of an outdoor hydraulic laboratory that has been established for a year for the purpose of studying erosion-control structures.

ROBERT J. WOOD, formerly with the American Institute of Steel Construction in St. Louis, Mo., is now engineer with the Mississippi Valley Structural Steel Company at Maplewood, Mo.

CLAUDE H. RICE has resigned from the U. S. Forest Service at Peru, Vt., to resume an active part in the engineering and architectural firm of Rice and Larson, of Manchester Center, Vt.

R. L. MEAD is now in the construction equipment division of the Chain Belt Company in Milwaukee, Wis.

DECEASED

RICHARD I. DOWNING ASHBRIDGE (M. '07) chief engineer for the Atlantic City and Shore Railroad, died in East Downingtown, Pa., on July 26, 1936. Mr. Ashbridge, who was 75, was a graduate of the University of Pennsylvania, class of 1881. From 1890 to 1903 he was in the Philadelphia Department of Public Works, in charge of the location and construction of numerous local sewerage, drainage, and tunnel projects. Later he became chief engineer for the Atlantic City and Shore Railroad, where he remained for many years.

WILLIAM BOWDOIN CAUSEY (M. '20) vice-president of the M. E. White Company, of Chicago, Ill., died in that city on August 10, at the age of 71. He was born in Suffolk, Va., and from 1883 to 1914 was engaged in railroad work for the Atlantic and Danville Railroad, the Union Pacific, and other lines. During the War he served with the 17th Engineers in France, and in December 1918 was sent to Vienna as a member of the American section of the Inter-Allied Mission to investigate economic conditions there. After five years of service he returned to this country and became city manager of Norfolk, Va., resigning in 1925 to join the White Construction Company and the M. E. White Company, general contractors, in Chicago.

STEPHEN CHILD (M. '98) landscape architect and consultant in city planning, San Francisco, Calif., died recently. He was born in Boston, Mass., on August 14, 1866, and graduated from the Massachusetts Institute of Technology in 1888. From 1891 to 1901 Mr. Child was assistant city engineer of Newton, Mass. In 1903 he established a private practice as landscape architect and city planner in Boston. A few years later he moved to San Francisco, where he continued in this practice. During the World War he served as district town planner for the U. S. Housing Corporation. Mr. Child was the author of many articles and reports.

FELIX GROVER DYHRKOPP (Assoc. M. '26) died recently in the Veterans Hospital at Milwaukee, Wis. Mr. Dyhrkopp was born in Spencer, Iowa, on November 15, 1892, and studied at the University of Iowa. During the war he served in the U. S. Army. From 1919 to 1925 he was assistant highway engineer for the state of Illinois. After being employed for two years as consulting engineer for the Hamilton Hoffman Construction Company, he returned to his former position, where he remained until the past year.

HARVEY FARRINGTON (M. '02) died at his home in Rangeley, Me., on July 18, 1936, at the age of 73. Mr. Farrington was born in New York City and graduated from the Sheffield Scientific School at Yale in 1886. For many years he was connected with the New York Central Railroad and the New York City Department of Docks, being employed as assistant engineer on the construction of piers, grain elevators, and improvements on the North and East rivers, the installation of a block signal system from New York to Utica, and many other projects. Later Mr. Farrington maintained a consulting and contracting engineer's office in New York City, retiring in 1921.

OTTO HENRY GENTNER, JR. (M. '17) consulting engineer of Philadelphia, Pa., died on July 6, 1936, at the age of 54. Mr. Gentner was born in Philadelphia and graduated from Drexel Institute in 1901. Prior to 1913, when he established his own consulting firm, he was employed in various capacities by several organizations, including the Unit Concrete Steel Frame Company, of Philadelphia; the General Fireproofing Company, of Youngstown, Ohio; the Philadelphia Fireproofing Company; and the Philadelphia Construction Company.

SIRI KRISHNA GURTU (M. '27) chief engineer, Kutch State, Bhuj, India, died at Agra on April 26, 1935. He was born in Delhi in 1873 and graduated from Punjab University in 1900. Mr. Gurtu's early engineering experience included road work and irrigation. From 1914 to 1921 he was chief engineer of irrigation for the state of Gwalior. Later he served as consulting engineer to various Indian states, and in 1929 he became chief engineer for the State of Kutch. He was the author of numerous articles.

GEORGE TILLINGHAST HAMMOND (M. '06) who was in the New York City Department of Sanitation for 43 years, died in Edgewood, R.I., on August 9, 1936, at the age of 72. He was born in Newport, R.I., and attended Columbia University. From 1891 until his retirement in 1933 Mr. Hammond was engaged in the design and construction of storm-water sewers, sewage-disposal plants, and similar projects for New York and Brooklyn. He also designed water-supply and sewage-disposal systems for other American municipalities and for cities in China and Java. During the War he was in charge of health and sanitation for 38 shipyards between Boston and Philadelphia.

THEODORE HENRY HINCHMAN (M. '24) a member of the engineering firm of Smith, Hinchman, and Grylls, Detroit, Mich., died at his home at Grosse Pointe Farms, Mich., on July 16, 1936. Mr. Hinchman, who was 66, was born in Detroit and graduated from the University of Michigan in 1891. Shortly after leaving college he organized the engineering firm, bearing his name, of which he was vice-president and treasurer at the time of his death. This firm was responsible for many of Detroit's largest office and industrial buildings, including the Penobscot, the Union Guardian, and the Dodge Brothers plants.

WILLIAM NELSON JONES (M. '17) supervisor of distribution and engineer for the water department of the city of Tampa, Fla., died on July 6, 1936, at the age of 57. Mr. Jones was born in Laramie, Wyo., and graduated from the University of Wisconsin in 1905. His major experience was in the water departments of Cincinnati, Louisville, and Minneapolis. For twelve years subsequent to 1921 he was in private

engineering practice in Tampa, Fla., entering the service of the city in 1933. Mr. Jones was the author of numerous publications.

ALVIN LE VAN (M. '20) city building inspector at Santa Monica, Calif., since 1932, died there on July 16, 1936, at the age of 61. Mr. Le Van was born at Guthrie Center, Iowa, and graduated from the University of Iowa in 1907. Soon after graduation he became chief engineer for N. M. Stark and Company, of Des Moines, where he remained until 1919 having full charge of design and construction work. In the latter year he became a member of the Canfield Engineering Company, Des Moines. In 1921 he established his own practice.

EDWARD SHERMAN NETTLETON (M. '26) city engineer of New Haven, Conn., died there on July 23, 1936, at the age of 67. Mr. Nettleton graduated from the Sheffield Scientific School at Yale in 1892. After leaving college, he was employed by the government on fortifications on Long Island, and later was assistant engineer of the Waterbury, Conn., water supply. In 1896 Mr. Nettleton joined the engineering staff of the city of New Haven, becoming city engineer in 1920. At the time of his death he was secretary of the city planning commission.

JAMES WILLIAM NORTON (Assoc. M. '20) engineer for CCC Camp S-51 at Noble, Ky., died on May 27, 1936. He was 48. Mr. Norton was born in Carlisle, Ky., and studied mining engineering at Kentucky State College. His early experience was with the Tennessee Coal, Iron and Railroad Company. From 1915 to 1920 he was county road engineer of Nicholas County, Kentucky. Later he established an engineering practice in Lakeland, Fla., remaining there until 1933.

FREDERICK EDWARD SCHALL (M. '02) who was connected with the Lehigh Valley Railroad Company for 53 years, died in Bethlehem, Pa., on August 6, 1936. Mr. Schall was born in Kuchen, Germany, on December 19, 1857, and gained his early experience in railway construction work in that country. In 1881 he came to the United States, and in 1883 entered the employ of the Lehigh Valley Railroad.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

Passing through various grades, he became bridge engineer in 1899 and consulting bridge engineer in 1929.

CLARENCE HORACE SCHWARTZ (Assoc. M. '20) senior engineer in the U. S. Engineer Office at Memphis, Tenn., died in the Veteran's Hospital there on June 28, 1936. He was 42. Lieutenant Schwartz was born in Jackson County, Ill., and graduated from the University of Kentucky in 1913. During the World War he served in the U. S. Engineer Corps. Following the War, he was assigned to supervise construction of power dams in the Miami Conservancy District of Dayton, Ohio. In 1928 he was transferred to the New Orleans District of the U. S. Engineers, and went to the Memphis district in 1930.

LEIDY RUDY SHELLENBERGER (M. '24) a retired civil engineer of Bayonne, N.J., died in that city on July 25, 1936, at the age of 71. He was born in Hilltown Township, Pa., and graduated from Lehigh University in 1891. Mr. Shellenberger's career included experience with the American Bridge Company at Pencoyd, Pa.; as designer on the construction of the Grand Central Terminal in New York City; and with the Public Service Commission of New York City. From 1921 to 1924 he was assistant engineer for the Vehicular Tunnel Commission of New York. In the latter year he became chief bridge designer for the New Jersey State Highway Commission, where he remained until his retirement in 1935.

ZENAS HARRISON SIKES (M. '16) assistant engineer of structures for the New York Central Railroad lines, New York City, died on August 1, 1936. He was born at Suffield, Conn., on March 5, 1874, and graduated from Sheffield Scientific School in 1898. After experience with the Pennsylvania Railroad Company he joined the staff of the New York Central in 1906. While with this road he supervised the design of the bridge over the Hudson River at Castleton and the design of three trunnion bascule railroad bridges.

GUSTAVE ADOLPH STRAND (Assoc. M. '22) chief engineer and sales manager for the Trojan Powder Company, San Francisco, Calif., died in October 1935. Mr. Strand was born on November 11, 1887, and began his engineering work in 1909, the year of his graduation from engineering school. From 1910 to 1911 he was with the Northwestern Pacific Railroad, and later he was city engineer for Eureka, Calif., for a number of years. In 1919 he became construction engineer for the Trojan Powder Company, where he remained until the time of his death.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From July 10 to August 9, 1936, Inclusive

ADDITIONS TO MEMBERSHIP

ACKERMAN, JEROME OTTO (Jun. '36), Associate Engr.-Office Asst. to Area Engr., U. S. Engr. Office (Res., 1003 Goodrich Ave.), St. Paul, Minn.

ANDERSON, MILTON (Assoc. M. '36), Junior Civ. Engr., Bureau of Water Works and Supply, Los Angeles (Res., 10831 Acama St., North Hollywood), Calif.

BABBITT, BENJAMIN TALBOT, JR. (Jun. '36), Junior Engr., U. S. Geological Survey, Box 346 (Res., 1217 Fifteenth St.), Sacramento, Calif.

BATES, WILLIAM JOURDAN (Jun. '36), 845 Ohio Ave., Youngstown, Ohio.

BLUM, ALBERT ELIAS (Jun. '36), Asst. Engr., Hygrade Const. Co., 341 Scholes St. (Res., 377 Ocean Parkway), Brooklyn, N.Y.

BOOTH, DONALD ALFRED (Jun. '36), Care, The Dravo Contr. Co., Winfield, W.Va.

BUFFUM, J. SAYLES (Assoc. M. '36), Asst. Civ. Engr., Transit Comm., 207 Madison Ave. (Res., 307 West 79th St.), New York, N.Y.

CAVENDISH, LYNN RAY (Assoc. M. '36), Senior Engr., State Road Comm., Charleston (Res., 328 Tremont St., South Charleston), W.Va.

CLARE JIMENEZ, MANUEL EMILIO (Jun. '36), Box 175, San José, Costa Rica.

CLARK, EDWARD ALLIS (Assoc. M. '36), Chf. Engr., Standard-Vacuum Oil Co., 15 Rua Horta Seca, Lisbon, Portugal.

CLARRIDGE, CHARLES EVANS (Jun. '36), Instr., Civ. Eng. Dept., Clarkson Coll. of Technology (Res., 74 Market St.), Potsdam, N.Y.

CORLEY, ROBERT HARE POWEL (Assoc. M. '36), Div. Engr., Philadelphia Rapid Transit Co. (Res., 552 Dupont St., Roxborough), Philadelphia, Pa.

CUSHING, PAUL JOSEPH (Jun. '36), Vice-Pres. and Treas., Hydr. Dredging Co., Ltd., 1221 Central Bank Bldg., Oakland, Calif.

DEVIDO, LEWIS ANDREW (Jun. '36), Junior Civ. Eng., ECW, CCC Camp, Port Republic (Res., 380 Livingston Ave., New Brunswick), N.J.

DONLEY, DAVID EDWARD (Assoc. M. '36), Associate Hydr. Engr., TVA (Res., 2730 Magnolia Ave.), Knoxville, Tenn.

DOUGHERTY, DANIEL MICHEAL (Assoc. M. '36), Executive Engr. and Project Mgr., S. & W. Constr. Co., 983 Shrine Bldg., Memphis, Tenn.

ESPY, CECIL JEFFERSON, JR. (Jun. '36), 1735 South East 23d Ave., Portland, Ore.

EWING, WESLEY CHARLES (Jun. '36), 180 Henry St., San Francisco, Calif.

GRIFFITH, JOHN OAKLEY (Jun. '36), Draftsman, Mt. Vernon Bridge Co., 504 East Chestnut St., Mount Vernon, Ohio.

HAASE, JOHN ALOYSIUS, III (Jun. '36), Buyer, Purchasing Depts., ERA, FERA, and U. S. Treasury Dept.; 8604 Pritchard Pl., New Orleans, La.

KENNEY, NORMAN DURLING (Assoc. M. '36), Care, Whitman, Requardt & Smith, West Biddle St. at Charles, Baltimore, Md.

LEACH, LAURENCE GAY (Jun. '36), With U. S. Engr. Office, Zanesville (Res., 14905 Elm Ave., East Cleveland), Ohio.

NESSLER, CHARLES WILLIAM HENRY (Assoc. M. '36), Associate Engr., U. S. Geological Survey, 1353 Highland Ave., Glendale, Calif.

OLSEN, BRUCE CHARLES (Jun. '36), 2037 Forty-Second Ave., North, Seattle, Wash.

PALMER, AUBREY EDWIN (Jun. '36), Student Engr., U. S. Bureau of Public Works, 217 Ninth Ave., South Charleston, W.Va.

PERRY, CLIFTON BENOIT (Jun. '36), Inventory Asst., Consolidated Gas Co., 4 Irving Pl., New York (Res., 15 Everett Ave., Ossining), N.Y.

PETRULLO, CARL FRANK (Jun. '36), 769 King St., Northumberland, Pa.

RAPHAEL, JEROME MAURICE (Jun. '36), Insp., U. S. Engrs., Tygart River Reservoir Dam (Res. 228 Riverside Drive), Grafton, W.Va.

ROBINSON, DELBERT WALTON (Assoc. M. '36), Water and Gas Engr., Community Public Service Co. (Res., 3113 Wabash St.), Fort Worth, Tex.

ROCKEFELLER, EDWARD JOHN (Jun. '36), Chf. of Party, State Highway Dept., 535 Whalley Ave., New Haven (Res., 133 Park Ave., Spring Glen, Hamden), Conn.

SCHRADER, FLOYD FRANKLIN (Assoc. M. '36), Associate Engr., U. S. Geological Survey, Water Resources Branch (Res., Monté Vistá, R.F.D. 7), Charlottesville, Va.

SCHWARTZMAN, NATHAN (Jun. '36), Draftsman, State Highway Dept., Frankfort (Res., 255 Stone Ave., Lexington), Ky.

SHOEMAKER, WILLIAM SUMMERS (Jun. '36), Engr., T. Calvin Owens, Box 5833, Bethesda, Md.

SLATTERY, LOUIS ALOYSIUS (Affiliate '36), Secy. and Treas., Lyons-Slattery Co., Inc.; Vice-Pres. and Gen. Mgr., Hudson River Stone Corporation (Res., 4525 Waldo Ave.), New York, N.Y.

SMITH, EZEKIEL JACKSON (M. '36), Div. Engr., State Highway Board, Box 57, Macon, Ga.

SMITH, PRESTON CLARK (Jun. '36), Student Engr. (Highway), U. S. Bureau of Public Roads, Washington, D.C. (Res., 2320 Inge St., South, Arlington, Va.)

STRONG, CHARLES HENDERSON (Jun. '36), Draftsman and Estimator with Fred H. Tibbetts, 1320 Alaska-Commercial Bldg. (Res., 2614 Webster St.), San Francisco, Calif.

TELLEPSEN, HOWARD TELLEF (Jun. '36), Estimator, Tellepsen Constr. Co., 3900 Clay Ave. (Res., 4518 Park Drive), Houston, Tex.

UPDEGROVE, JACOB WALTER (Jun. '36), Draftsman, L. V. R. R., Bethlehem (Res., 243 Bushkill St., Easton), Pa.

WHALLEY, ALBERT EDWARD, JR. (Jun. '36), Res. Engr., Water Works and Sewers, Freeland, Roberts & Co. (Res., 110 Park Circle), Nashville, Tenn.

WIGLEY, ARTHUR BROWNING (Jun. '35), Care, TVA, Union Bldg., Knoxville, Tenn.

WILKINSON, READ ARTHUR (Jun. '36), Engr., SCS, ECW 7, U. S. Dept. of Agriculture (Res., 409 South 6th St.), Burlington, Kans.

WILLIAMSON, FRANK MARTIN (Assoc. M. '36), Asst. Civ. Engr., San. Dist. of Chicago (Res., 7649 Calumet Ave.), Chicago, Ill.

WOODHOUSE, HARRY HERBERT (Assoc. M. '36), 1712 First Ave., New York, N.Y.

WOOLSEY, WALTER BENJAMIN (Assoc. M. '36), Director, Building Management and Supply Div., Emergency Relief Bureau (Res., 215 West 23d St.), New York, N.Y.

MEMBERSHIP TRANSFERS

BERRYMAN, RUSSELL GARDNER (Assoc. M. '28; M. '36), Engr., Day & Zimmermann, Inc., Packard Bldg. (Res., 6431 North 17th St.), Philadelphia, Pa.

BROTHERTON, WILLIAM WALLIS (Jun. '28; Assoc. M. '36), Dept. of Civ. Eng., Coll. of the City of New York, 139th St. and Convent Ave. (Res., 203 West 85th St.), New York, N.Y.

CLARK, HOWARD FOSTER (Jun. '14; Assoc. M. '16; M. '36), Capt., Corps of Engrs., U.S.A., Fort Bliss, El Paso, Tex.

CLOOS, GEORGE PHILLIP (Jun. '27; Assoc. M. '36), 9416 Park Lane South, Woodhaven, N.Y.

CONDRON, ARNOLD LAYMAN (Jun. '28; Assoc. M. '36), Asst. Designer, Bridge Dept., State Highway Comm. (Res., 625 Irvington Rd.), Topeka, Kans.

CUMMINGS, ALBERT EDWARD (Assoc. M. '22; M. '36), Dist. Mgr., Raymond Concrete Pile Co., 111 West Monroe St., Room 1912, Chicago, Ill.

DAY, CHARLES GOODWIN (Jun. '30; Assoc. M. '36), Constr. and Maintenance Engr., New Eastern State Penitentiary, Graterford (Res., 5013 North 17th St., Philadelphia), Pa.

ENGLISH, CHARLES CARMEN (Jun. '23; Assoc. M. '28; M. '36), Cons. Engr., 2101 East 100th St., Cleveland, Ohio.

FENNER, JOHN SHERROD (Assoc. M. '22; M. '36), County Engr., Bee County, Beeville, Tex.

FENWICK, KENNETH MACDONALD (Jun. '29; Assoc. M. '36), Asst. Res. Engr., State Div. of Highways, Dist. VII (Res., 1124 South Manhattan Pl.), Los Angeles, Calif.

FRIEDMAN, EDMUND (Assoc. M. '27; M. '36), County Engr., Dade County, 1301 Court House, Miami, Fla.

GARDINER, JOHN HAINES (Jun. '23; Assoc. M. '26; M. '36), Dist. Engr., Water Resources Branch, U. S. Geological Survey, Fort Smith, Ark.

GAUTHIER, PAUL GILLES (Jun. '24; Assoc. M. '29; M. '36), Townsite Engr., Ontario Paper Co., Montreal (Res., 660 de l'Epee Ave., Outremont), Que., Canada.

GWATHMEY, WILLIAM WATTS, JR. (Assoc. M. '25; M. '36), Asst. Engr., B. & O.R.R., Jarrett Bldg., Grafton, W.Va.

HARKNESS, DANIEL HOOVER (Jun. '29; Assoc. M. '36), Instr. in Civ. Eng., Univ. of Nebraska, Mechanic Arts 105, Univ. of Nebraska, Lincoln, Nebr.

TOTAL MEMBERSHIP AS OF AUGUST 9, 1936	
Members	5,720
Associate Members	6,245
Corporate Members	11,965
Honorary Members	19
Juniors	3,253
Affiliates	95
Fellows	1
Total	15,333

HOPFBERG, WILLIAM ARNOLD (Jun. '27; Assoc. M. '36), 1615 Walton Ave., New York, N.Y.

HOWES, HERBERT ELLSWORTH (Assoc. M. 15; M. '36), Asst. Regional Engr., Region 6, U.S. Forest Service, Box 4137, Portland, Ore.

HUNTING, EUGENE NATHAN (Jun. '04; Assoc. M. '08; M. '36), Engr. and Archt. (Hunting, Davis & Dunnells), 1150 Century Bldg., Pittsburgh, Pa.

JARVIS, WALTER MONROE (Jun. '25; Assoc. M. '27; M. '36), Asst. Dist. Engr. and Dist. Supervisor, Div. of Projects and Planning, WPA, Box 209, London, Ky.

JESSUP, ALBERT HALL (Assoc. M. '27; M. '36), Designing Engr., Quinton, Code & Hill-Leeds & Barnard, Suite 905, Edison Bldg., Los Angeles (Res., 224 North Segovia Ave., San Gabriel), Calif.

JOYNER, CALVIN NICOLAS (Jun. '27; Assoc. M. '29; M. '36), Deputy Municipal Engr., British Municipal Council, Tientsin, China.

KIMBROUGH, CLYDE WILLIAM (Jun. '31; Assoc. M. '36), Prin. Draftsman, Bonneville Power and Nav. Project, U. S. Engrs., Bonneville, Ore.

LIND, HERBERT WILLIAM (Jun. '30; Assoc. M. '36), Transitman, N.Y.C.R.R., New York (Res., 734 East 9th St., Brooklyn), N.Y.

MARSON, HOMER ROBERTS (Assoc. M. '25; M. '36), Civ. Engr., Budget Bureau, City of Detroit, 1908 Water Board Bldg., Detroit, Mich.

POOL, CHARLES LUNDY (Assoc. M. '24; M. '36), San. Engr. and Chemist, State Dept. of Public Health, 333 State Office Bldg., Providence, R.I.

REED, OREN (Jun. '24; Assoc. M. '27; M. '36), Asst. Constr. Engr., TVA, Pickwick Dam, Tenn.

SHULITS, SAMUEL (Jun. '25; Assoc. M. '36), Asst. Prof., Mechanics and Hydraulics, Colorado School of Mines, Golden, Colo.

SNYDER, CHARLES WILMER (Jun. '29; Assoc. M. '36), Structural Engr., Acme Steel Eng. Co., 917 South Howard St. (Res., 3401 Fairview Ave.), Baltimore, Md.

THACKWELL, HENRY LAWRENCE (Jun. '12; Assoc. M. '16; M. '36), Cons. and Const. Engr., 209 East Cotten St., Longview, Tex.

WALLACE, GORDON (Jun. '31; Assoc. M. '36), Chf. Eng. Draftsman, Public Works Dept. 3d Naval Dist. (Res., 606 West 191st St.), New York, N.Y.

WANDERER, HENRY GEORGE (Jun. '28; Assoc. M. '36), Asst. Dist. Engr., CWA and TERA of New York State, Rockland and Westchester Counties; 170 Grand St., White Plains, N.Y.

WEAVER, FRANK LLOYD (Jun. '16; Assoc. M. '20; M. '36), Rate Engr. and Analyst, Elec. Rate Survey, Federal Power Comm., Washington, D.C. (Res., 15 Keswick St., Garrett Park, Md.).

REINSTATEMENTS

AJWANI, HASHU J., Assoc. M., reinstated Nov. 18, 1935.

ESTES, FRANKLIN EDWARD, M., reinstated June 15, 1936.

HOOPER, LEWIS GLADSTONE, M., reinstated July 6, 1936.

REED, CHARLES ALLEY, M., reinstated July 6, 1936.

RESIGNATIONS

BJORNSTAD, BJARNE THORLEIF, Jun., resigned July 16, 1936.

EMERSON, CHARLES JOHN, Assoc. M., resigned July 24, 1936.

PETERSON, HILMER FREDERIC, Assoc. M., resigned July 22, 1936.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

September 1, 1936 NUMBER 9

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information. Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years†	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.

† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

ADMISSIONS

ADAMS, ALEXANDER SEMONES, Fort Worth, Tex. (Age 60.) Traveling Engr. Inspector, PWA. Refers to H. B. Friedman, J. C. McVea, J. Montgomery, J. M. Nagle, M. C. Nichols, R. D. Parker, U. Stephens, G. C. Street, Jr., R. A. Thompson, P. A. Welty.

ALDOHN, WILLIAM PHILLIP, Pullman, Wash. (Age 23.) Refers to H. E. Phelps, M. K. Snyder, J. G. Woodburn.

ALPER, ALBERT, St. Louis, Mo. (Age 23.) Civ. Engr., United Constr. Co. Refers to C. E. S. Bardsley, J. B. Butler, E. W. Carlton, E. G. Harris.

ANDERSON, CLARK MACKER, Los Angeles, Calif. (Age 33.) With Los Angeles County Flood Control. Refers to R. C. Booth, S. M. Fisher, J. H. Freeman, K. J. Harrison, N. B. Hodgkinson, H. C. McDonald, W. J. Manetta.

ANDRUS, FREDERICK MARIAN, Los Angeles, Calif. (Age 24.) Refers to R. M. Fox, D. M. Wilson.

ARMENTROUT, JOHN BENJAMIN, Bethesda, Md. (Age 22.) Engr., College Park Bldg. Corporation, College Park, Md. Refers to A. N. Johnson, P. G. Lang, Jr., S. S. Steinberg.

ARMSTRONG, ELLIS LEROY, Bridgeland, Utah. (Age 22.) Concrete Inspector, U. S. Bureau of Reclamation. Refers to G. D. Clyde, O. W. Israelsen, H. R. Kepner.

ASH, LAWRENCE EDGAR, Brooklyn, N.Y. (Age 36.) With Resettlement Administration, Grade P 1. Refers to G. S. Baton, L. P. Blum, C. B. Breed, H. A. Cotton, J. R. Elliott, W. A. Weldin.

ASHLOCK, EVAN EARL, Alcova, Wyoming. (Age 39.) Engr. with W. E. Callahan Constr. Co., Dallas, Tex. Refers to R. M. Conner, O. N. Floyd, W. W. Horner, W. K. McIlyar, H. Shifrin, J. E. Vollmar.

AUSTIN, HARRISON LOCKWOOD, Concordia, Kans. (Age 43.) Res. Engr., Grade B, Kansas Highway Comm. Refers to S. Baker, E. H. Dunmire, R. M. Green, R. J. Paulette, I. E. Taylor, M. W. Watson.

AUSTIN, ROBERT EDWARD, Jacksonville, Fla. (Age 22.) Refers to G. M. Keith, T. M. Lowe, P. L. Reed, W. L. Sawyer.

BAPTISTA, FREDERICK WILLIAM, New York City. (Age 22.) Refers to R. C. Brumfield, F. E. Foss, G. Morrison, W. H. Yates.

BARBER, JESSE BYRON, Pullman, Wash. (Age 22.) Refers to H. E. Phelps, M. K. Snyder, J. G. Woodburn.

BARRUS, WINFORD MELVIN, Roosevelt, Utah. (Age 24.) Asst. Irrigation Engr. with Resettlement Administration, Land Utilization Div. Refers to G. D. Clyde, O. W. Israelsen, H. R. Kepner.

BARTUS, JULIUS FRANCIS, Milford, Mich. (Age 22.) Batch Plant Inspector, Gen. Motors Proving Ground. Refers to M. R. Fisher, L. M. Gram, L. C. Maugh, R. H. Sherlock, L. C. Wilcoxen.

BEARSE, IRVING WOOD, Hyannis, Mass. (Age 21.) Refers to H. C. Bird, W. H. Hall.

BEAVERS, MERWIN GORDON, Austin, Tex. (Age 20.) Refers to E. C. H. Bantel, V. L. Beavers, W. D. Dockery, J. A. Focht, T. U. Taylor.

BECKER, FRANCIS SHERWOOD, Oak Bluffs, Mass. (Age 24.) Refers to L. W. Clark, T. R. Lawson, H. O. Sharp.

BENNETT, PAUL DENNEY, Chicago, Ill. (Age 21.) Refers to W. G. Arn, T. L. Condron, A. J. Hammond, R. E. Hutchins, R. L. McCormick.

BERRIEN, EDWIN RIVERS, Yuma, Ariz. (Age 23, U. S. Bureau of Reclamation, Imperial Dam. Refers to B. A. Etcheverry, S. T. Harding.

BLACK, IRVING, Brooklyn, N.Y. (Age 22.) Refers to R. C. Brumfield, F. E. Foss, G. Morrison.

BLUMBERG, CHARLES, Wyomissing, Pa. (Age 26.) Refers to H. M. Braloff, D. M. Griffith, J. Meltzer, G. Paaswell.

BORCHELT, THOMAS CHARLES, Pekin, Ill. (Age 22.) Refers to H. C. Bird, W. M. Piatt.

BOVAY, HARRY ELMO, Jr., Vicksburg, Miss. (Age 22.) Jun. Engr., Missouri Valley Bridge & Iron Co. of Leavenworth, Kans. Refers to F. A. Barnes, J. E. Perry.

BOYER, JOHN PARKE, Decatur, Ill. (Age 23.) Refers to N. D. Morgan, C. E. Palmer.

BRIGHAM, LESLIE ELIJAH, Klamath Falls, Ore. (Age 47.) Res. Engr. Inspector for PWA. Refers to R. H. Corey, C. C. Hockley, F. Merryfield, C. A. Mockmore, H. S. Rogers, O. E. Stanley, J. C. Stevens.

BURNS, THOMAS STEPHEN, Denison, Tex. (Age 46.) Prin. Asst., U. S. Engr. Office. Refers to N. W. Bowden, H. J. Casey, C. C. Chambers, A. W. Consoer, W. P. Creager, E. S. Cullings, F. B. Duis, F. P. Fifer, G. H. Friend, J. D Justin, P. F. Kruse, W. H. McAlpine, A. L. Pauls, L. A. Whitsit.

BUTLER, JOHN SOULE, Jr., Chicago, Ill. (Age 22.) Rodman, Chicago, Milwaukee & St. Paul R.R. Refers to R. A. Caughey, A. H. Fuller, F. Kerekes, A. D. Kidder, J. C. Thoma.

BUTTERS, HAROLD AARON, Jr., Belmont, Mass. (Age 26.) Refers to J. W. Howard, J. D. Mitsch.

CAMERON, HARRY ROBERT, Pittsburgh, Pa. (Age 21.) Draftsman, Pittsburgh Bridge & Iron Works. Refers to F. J. Evans, C. B. Stanton.

CARLSON, CONRAD VICTOR, Axtell, Nebr. (Age 26.) Jun. Engr., CCC Camp, Soil Conservation Service. Refers to M. I. Evinger, H. J. Kesner, C. E. Mickey.

CARRUTH, JOHN HILL, Norfolk, Va. (Age 46.) Dist. Engr., Norfolk, Va., Asst. to Chf. of Engrs., WPA, U. S. War Dept., Washington, D.C. Refers to E. S. Bres, F. C. Carey, J. F. Coleman, W. B. Gregory, J. Klorer, R. M. McCrone, B. W. Pegues.

CARSON, ALBERT CASSON, Wellsboro, Pa. (Age 23.) Refers to D. M. Griffith, O. L. King.

CARTELLI, VINCENT ROBERT, New York City. (Age 25.) With EHRB. Refers to C. E. Durr, Jr., C. T. Schwarze, D. S. Trowbridge.

CASPERSSON, STEN ANDERS, Brooklyn, N.Y. (Age 26.) Refers to F. E. Foss, G. Morrison, J. P. J. Williams.

CERVANTES, JOSE MALO, Columbia, Mo. (Age 27.) Refers to R. B. B. Moorman, H. K. Rubey.

CHALBERG, FRANK WALTER, Montgomery, Ala. (Age 24.) Laboratory Asst., State Highway Dept. of Alabama, testing materials. Refers to G. J. Davis, Jr., D. C. A. de Plantier.

COLGLAZIER, ROBERT WESLEY, Jr., San Antonio, Tex. (Age 31.) Asst. Director, Texas WPA, Dist. 10 (20 counties). Refers to J. C. Bisset, W. S. Goodman, J. T. L. McNew, E. W. Robinson, R. G. White.

COOPER, HAROLD HOWARD, Lansing, Mich. (Age 23.) Bridge Draftsman, Michigan State Highway Dept. Refers to C. L. Allen, C. M. Cade, H. L. Conrad.

COPELAND, WILLIAM EDWARD, Columbia, S.C. (Age 21.) Road Draftsman, South Carolina Highway Dept. Refers to E. L. Clarke, D. D. Curtis.

CRABIEL, JOSEPH EDWARD, Milltown, N.J. (Age 20.) Refers to H. N. Lendall, R. R. Nace.

CREAL, ALBERT, Hollywood, Calif. (Age 22.) Refers to W. W. Michael, F. Thomas.

CRESSON, WILLIAM JAMES, Jr., Swarthmore, Pa. (Age 27.) With Atlantic Refining Co., Philadelphia, Pa. Refers to E. M. Bassett, S. B. Lilly.

CULLUM, ROBERT SEVERNE, San Angelo, Tex. (Age 31.) Dist. Field Supervisor and Supervisor of Safety, WPA, Dist. No. 19. Refers to E. A. Baugh, J. C. Bisset, H. T. Boyle, H. W. English, H. P. Kay, T. C. Shuler.

CURTIS, ARNOLD, Riverside, Calif. (Age 24.) Refers to W. R. Chawner, B. A. Etcheverry, S. T. Harding, C. G. Hyde, F. C. Scobey.

DAMIANO, VINCENT FERDINAND JOSEPH, Reading, Mass. (Age 26.) Engr., U. S. Forest Service, ECW., Camp S-76, No. Reading, Mass. Refers to E. Mirabelli, W. C. Voss.

DAVIDSON, WILLIAM EDWARD, Merrill, Ore. (Age 25.) Senior Foreman Engr., National Park Service, Lava Beds National Monument, Calif. Refers to T. R. Lawson, H. O. Sharp.

DE HART, BRUCE HARDING. (Age 22.) Laramie, Wyoming. Refers to R. D. Goodrich, H. T. Person.

DODGE, CHARLES HOPKINS, Ojai, Calif. (Age 23.) Engr., California Water Service Corporation, on various studies. Refers to E. L. Grant, S. B. Morris, C. Moser, L. B. Reynolds, E. C. Thomas.

DOUGHERTY, HENRY WARD, Huntsville, Ala. (Age 21.) Jun. Eng. Aide, TVA. Refers to F. H. Conley, R. L. Moore, F. W. Truss.

DOUGLASS, WILFORD FRANKLIN, Bristol, Tenn. (Age 30.) Superv. Engr., Tri-City Airport, WPA. Refers to R. H. Baker, C. W. Butts, A. R. Jessup, W. F. Moehlman, J. E. Moreland, R. L. Morrison, M. U. Snoderly.

ECKARDT, EUGENE PHILLIP, Ann Arbor, Mich. (Age 22.) Refers R. L. McNamee, L. C. Maugh, R. H. Sherlock.

EEDS, WALTER LEARY, Temple, Tex. (Age 23.) Jun. Photogrammetrist, Brazos River Conservation and Reclamation Dist., Temple, Tex. Refers to J. T. L. McNew, T. A. Munson.

EFFENBERGER, EWALD JOSEPH, Shiner, Tex. (Age 23.) Refers to L. E. Grinter, J. J. Richey

ELSNER, RALPH AUGUST, Joplin, Mo. (Age 23.) Party Chf., Missouri State-Wide Highway Planning Survey, State Highway Comm. Refers to R. B. B. Moorman, H. K. Rubey.

EMERSON, ARTHUR HENRY, Watertown, N.Y. (Age 51.) Vice-Pres. and Secy., The William T. Field Engrs., Inc. Refers to E. S. Cullings, W. H. Cushman, W. T. Field, R. F. Hall, A. W. Harrington, C. A. Pohl, F. C. Wilson.

FICOCIELLO, ANTHONY PELLEGRINO, Passaic, N.J. (Age 22.) Refers to H. N. Cummings, W. S. LaLonde, Jr.

FILLEY, DAVID CHILD, San Antonio, Tex. (Age 22.) Refers to J. A. Focht, G. H. Guerdrum.

FISH, WILLIAM BAKER, Springfield, Ill. (Age 21.) Refers to W. J. Carrel, J. W. Guyn, R. E. Shaver, D. V. Terrell, J. S. Watkins.

FISHER, RICHARD EVAN, Carnegie, Pa. (Age 22.) Refers to C. T. Morris, C. E. Sherman.

FOGLE, JAMES GERALD, Potlatch, Idaho. (Age 24.) Plant Inspector, State of Idaho. Refers to J. E. Buchanan, I. C. Crawford.

FRANK, HOWARD GREENLEAF, Hamilton, Square, N.J. (Age 24.) Refers to D. M. Griffith, O. L. King.

FRATE, LAWRENCE PETER, Milldale, Conn. (Age 21.) Refers to T. R. Lawson, E. R. Wiseman.

GAGON, GEORGE F., Gary, Ind. (Age 22.) Draftsman, American Bridge Co. Refers to J. E. Buchanan, I. C. Crawford, J. W. Howard.

GEHM, HAROLD MARVIN, Niles, Mich. (Age 23.) Refers to N. D. Morgan, C. E. Palmer.

GERPEN, WILLIAM HOWARD, Monterey Park, Calif. (Age 21.) Refers to R. R. Martel, W. W. Michael, F. Thomas.

GODAT, DAVID WALKER, New Orleans, La. (Age 39.) Maintenance Engr., Div. of Public Works. Refers C. G. Cappel, J. deTarnowsky, A. H. Guillot, F. P. Hamilton, W. T. Hogg, C. M. Kerr, J. Klorer, N. E. Lant, G. P. Rice, A. F. Theard.

GOLDSWORTHY, FRED MICKELWAIT, Albuquerque, N.Mex. (Age 22.) Refers to J. H. Dorroh, H. C. Neuffer.

GOUINLOCK, GEORGE LINZY, Knoxville, Tenn. (Age 22.) Refers to E. F. Berry, L. Mitchell, S. D. Sarason.

GRAHAM, LESLIE WALLACE, San Francisco, Calif. (Age 23.) Structural Draftsman, San Francisco Bay Exposition Co. Refers to L. B. Reynolds, J. B. Wells.

GREELEY, RICHARD FOLSOM, Hudson, Mass. (Age 21.) Refers to H. P. Burden, R. W. Lefavour, F. N. Weaver, E. H. Wright.

GREENFIELD, FRANK LYNNE, Flushing, N.Y. (Age 43.) Asst. Superv. Engr., Highway Dept., project for Pres. of Borough of Manhattan, with WPA, New York City. Refers to C. S. Bilyeu, D. F. Giboney, A. T. Moran, E. C. Schmidt, T. F. Weiss, H. B. Wheatcroft, Jr.

GUILD, JOSEPHUS CONN, Jr., Chattanooga, Tenn. (Age 48.) Pres., The Tennessee Elec. Power Co. Refers to E. E. Betts, O. J. Miller, J. E. Morelock, A. F. Porzelius, W. H. Sears, D. H. Wood.

GULIAN, GEORGE, Newton, Mass. (Age 23.) Refers to G. M. Fair, A. Haertlein.

HALL, JAY V., Jr., Washington, D.C. (Age 30.) Asst. Engr., U. S. Beach Erosion Board, in charge of Wave Tank, Ft. Belvoir, Va. Refers to E. I. Brown, R. G. Davis, E. J. Dent, V. Gelineau, R. K. Hale, L. H. Hewitt, T. Saville, S. S. Steinberg.

HALL, WESLEY MILES, Brownwood, Tex. (Age 31.) Res. Engr., Div. 23, Brown and Coleman Counties, Texas State Highway Dept. Refers to J. A. Focht, W. A. French, C. S. Henning, Jr., A. F. Moursund, A. D. Schmid, M. C. Welborn, W. W. Wilkerson.

HAMILTON, WILLIAM CLIFFORD, Berkeley, Calif. (Age 22.) Refers to C. T. Wiskocil, L. K. Wood.

HARLEY, ROY GRANT, Cleveland Heights, Ohio. (Age 22.) Engr., American Steel & Wire Co., Cleveland, Ohio. Refers to G. E. Barnes, G. B. Earnest, F. L. Plummer.

HEITMAN, RICHARD HENRY, Marion, Iowa. (Age 22.) Rodman, Chicago, Milwaukee, St. Paul & Pacific R.R. Refers to R. A. Caughey, A. H. Fuller, F. Kerekes.

HERMANN, ARNE KURT PETER, Saginaw, Mich. (Age 22.) Inspector, Saginaw Malleable Iron Div., Gen. Motors Corporation. Refers to C. E. S. Bardsley, J. B. Butler, E. W. Carlton, E. G. Harris.

HOCKER, JOSEPH EDWARD, Owensboro, Ky. (Age 23.). Refers to W. J. Carrell, F. C. Dugan, R. E. Shaver, D. V. Terrell, J. S. Watkins.

HOLLIDAY, ALAN WASHBURN, Laramie, Wyo. (Age 21.) Refers to R. D. Goodrich, E. K. Nelson, H. T. Person.

HOLTON, HYRUM PERRY, Chattanooga, Tenn. (Age 26.) Topographic Draftsman, U. S. Army Engrs. Refers to G. D. Clyde, O. W. Israelsen, H. R. Kepner.

HOPEWELL, HENRY MCVICAR, Waterville, Wash. (Age 26.) Refers to H. E. Phelps, M. K. Snyder, J. G. Woodburn.

HUGER, BERNARD JOSEPH, St. Louis, Mo. (Age 27.) Refers to A. H. Holt, W. W. Horner, S. W. Jens, B. J. Lambert, C. C. Williams.

HUGHES, HOFFMAN CASTLETON, Salt Lake City, Utah. (Age 24.) Refers to T. C. Adams, R. B. Ketchum.

IRELAND, EMORY, Apollo, Pa. (Age 21.) Gas and Oil Engr., Peoples Natural Gas Co., Pittsburgh, Pa. Refers to R. P. Davis, W. S. Downs.

IZZARD, CARL FREDERICK, Austin, Tex. (Age 31.) Asst. Highway Engr., U. S. Bureau of Public Roads. Refers to T. W. Allen, J. C. Carpenter, J. C. L. Fish, T. E. Huffman, C. H. Kendall, L. B. Reynolds.

JACKSON, MCKINLEY, Walla Walla, Wash. (Age 39.) Dist. Engr., acting as Superv. Engr., U. S. Dept. of Agriculture, Soil Conservation. Refers to J. E. Buchanan, I. N. Carter, I. C. Crawford, H. M. Hadley, J. W. Howard.

JOHNSON, EMORY EMMANUEL, Lincoln, Nebr. (Age 22.) Refers to C. M. Duff, M. I. Evinger, D. H. Harkness, H. J. Kesner, C. E. Mickey.

JOINER, JAMES ROBERT, Austin, Tex. (Age 20.) Asst. Engr., Bridge Div., State Highway Dept. of Texas. Refers to L. E. Grinter, J. T. L. McNew, J. J. Richey, C. E. Sandstedt.

JONES, KARL NICKOLAUS, Seattle, Wash. (Age 23.) Refers to A. D. Butler, E. B. Crane, H. E. Phelps, M. K. Snyder, J. G. Woodburn.

JONES, PAUL STEVENSON, Independence, Calif. (Age 22.) Jun. Civ. Engr., Grade A., Dept. of Water & Power, Los Angeles, Calif. Refers to F. J. Converse, D. A. Lane, W. W. Michael.

KAFF, JOHN WORLEY, Overland Park, Kans. (Age 21.) Rodman, Kansas Highway Comm. Refers to E. Boyce, G. W. Bradshaw, J. O. Jones, W. C. McNown, F. A. Russell.

KEOSAIAN, EDWARD, New York City. (Age 21.) Rodman with Borough Pres. of Manhattan. Refers to W. Allan, R. E. Goodwin.

KIMPEL, CLINTON BIRNIE, Aspinwall, Pa. (Age 23.) With Gulf Research & Development Corporation, Pittsburgh, Pa. Refers to F. M. McCullough, H. A. Thomas.

KING, HAYDEN MCKAY, Anchorage, Ky. (Age 30.) Asst. Supervisor, Div. of Operations, Dist. No. 6, Kentucky WPA. Refers to G. R. Bickel, W. M. Caye, C. W. Lovell, W. E. Rodgers, C. H. Shea, J. Wilson.

KLINE, CARROLL NATHAN RAVER, Uniontown, Pa. (Age 35.) Asst. Dist. Director, Supervisor of Highway Projects and Supervisor, Div. of Operations, Dist. 16, WPA. Refers to H. C. Berry, A. J. Boase, W. H. Gibson, E. T. Grandlienard, W. S. Pardoe, F. G. Schworm.

KNIGHT, STERLING JULIUS, New Orleans, La. (Age 20.) Refers to D. Derickson, W. B. Gregory.

KRAPF, EARL DANIEL, Wilmington, Del. (Age 21.) Draftsman, Delaware State Highway Dept. Refers to T. D. Mylrea, H. K. Preston.

LAMB, GEORGE WILLIAM, Chanute, Kans. (Age 36.) Asst. Div. Engr., 4th Div., Kansas Highway Comm. Refers to C. J. Eidmann, F. W. Epps, R. D. Finney, L. Grover, W. C. McNown, J. Singleton, R. M. Willis.

LAMB, MAX FRANCIS, Coldwater, Kans. (Age 26.) Rodman, Kansas Highway Comm. Refers G. W. Bradshaw, W. C. McNown, F. A. Russell.

LAWRENCE, CLIFFORD DEAN, Logan, Utah. (Age 25.) Draftsman, Resettlement Administration, Land Utilization Div. Refers to G. D. Clyde, O. W. Israelsen, H. R. Kepner.

LEOPOLD, LUNA BERGERE, Madison, Wis. (Age 20.) Refers to F. M. Dawson, L. F. Van Hagan.

LEVITT, STANLEY MANUAL, New York City. (Age 21.) Refers to J. B. Babcock, 3d, T. R. Camp, L. S. Moisseiff.

LEVY, MARCUS WESTERFELD, Chicago, Ill. (Age 22.) Refers to N. D. Morgan, C. E. Palmer.

LEWIS, WAYNE CUTHBERT, Madison, Wis. (Age 22.) Eng. Aid, Div. No. 1, Wisconsin Highway Comm. Refers to H. F. Janda, L. F. Van Hagan.

LORING, SAMUEL JASPER, East Hartford, Conn. (Age 22.) With Chance Vought Aircraft Co. Refers to W. M. Fife, J. D. Mitsch.

MCGIBBON, KENNETH ARTHUR. (Age 22.) Rodman, Wyoming State Highway Department, Laramie, Wyoming. Refers to R. D. Goodrich, H. T. Person.

MCILHENNY, THOMAS HENRY FRANKLIN, Austin, Tex. (Age 23.) Refers to J. T. L. McNew, J. J. Richey.

MCLAUGHLIN, WILLIAM COLEMAN, Hatch, N. Mex. (Age 30.) Inspector, U. S. Bureau of Reclamation, Caballo Dam. Refers to J. L. Brown, S. F. Crecelius, B. G. Dwyre, L. M. Lawson, T. H. McCarthy, W. A. Von Schoeler.

MCNEIL, LAURENCE KRUEGAR, Casper, Wyo. (Age 23.) Refers to R. D. Goodrich, H. T. Person.

MABIN, THOMAS HERBERT, Troy, N.Y. (Age 21.) Refers to W. J. Farrisee, F. C. Wilson.

MANDEVILLE, RICHARD JAMES, Casper, Wyo. (Age 22.) Refers to R. D. Goodrich, H. T. Person.

MARTINE, FRANKLIN ARCHIE, Dallas, Tex. (Age 27.) Chf. Office Engr., Texas Centennial Exposition. Refers to J. T. Conroy, E. Couch, J. D. Fowler, T. G. MacCarthy, E. L. Myers, E. N. Noyes, C. L. Williford.

MARTINSON, NORMAN LOUIS, Long Beach, Calif. (Age 23.) Refers to L. W. Clark, H. O. Sharp.

MENEFEE, JAMES HENDRIX, Effingham, Ill. (Age 21.) Highway Engr., Design Office, Illinois Highway Dept., Dist. No. 7. Refers to C. E. S. Bardsley, J. B. Butler.

MEREDITH, ROGER D., Safford, Ariz. (Age 35.) Asst. Dist. Administrator, ECW, Soil Conservation Service. Refers to L. Aldrich, W. H. Becker, C. E. Griggs, A. F. Harter, C. A. Lewis, Jr., P. M. Lewis, C. L. Meng, S. Smyth.

MERRIMAN, CARROLL RICKS, Kokomo, Ind. (Age 24.) Refers to R. E. Hutchins, R. L. McCormick.

MILFORD, THOMAS HENRY, Montgomery, Ala. (Age 33.) Asst. San. Engr., Alabama State Health Dept. Refers to E. Boyce, J. B. Converse, W. Finnell, H. H. Hendon, J. E. Jagger, H. E. Miller, W. G. Stromquist, R. L. Totten, A. H. Wieters.

MILLER, JOHN EDWARD, Lansing, Mich. (Age 25.) Refers to R. B. Kittredge, B. J. Lambert, E. L. Waterman.

MILLIS, RALPH, Wilmington, N.C. (Age 42.) Major (Dist. Engr.), Corps of Engrs., U. S. Army. Refers to W. J. Barden, J. W. Barker, E. I. Brown, R. P. Howell, E. M. Markham, J. Millis, D. L. Neuman, G. B. Pillsbury, R. F. Rhodes, C. J. Robison, C. M. Spofford, M. C. Tyler.

MOOREY, ERNEST THOMPSON, Bridgeport, Conn. (Age 22.) Refers to H. C. Bird, W. H. Hall, H. W. Kueffner, W. W. Lewis.

MORRILL, LAREN D., Duchesne, Utah. (Age 22.) With U.S.B.R., Moon Lake Dam. Refers G. D. Clyde, O. W. Israelsen, H. R. Kepner.

MORSE, CHARLES ADELBERT, II, Los Angeles, Calif. (Age 22.) Refers to W. W. Michael, F. Thomas.

MUNRO, FRANK WARREN, PORTLAND, ORE. (Age 21.) Office Asst., Columbia Eng. Co. Refers L. B. Reynolds, J. B. Wells.

NEWBERRY, RAGAN MCGREGOR, Neodesha, Kans. (Age 28.) Prin. Asst. to City Engr. Refers to C. P. Donald, W. B. Hedges, F. M. Veatch, N. T. Veatch, Jr., L. A. Weeks.

NEWMAN, JOSEPH JOHN, Baraga, Mich. (Age 21.) Instrumentman, Michigan State Highway Dept., Baraga, Mich. Refers to H. W. King, R. H. Sherlock, C. O. Wisler.

NEWTON, DUDLEY, Detroit, Mich. (Age 39.) Asst. Prof. and Head of Dept., of Civ. Eng., Wayne Univ. Refers to C. O. Barton, J. P. Hallihan, C. W. Hubbell, R. L. Morrison, A. Roth, J. S. Worley.

O'BRIEN, RICHARD FRANCIS, Detroit, Mich. (Age 24.) Engr., O. W. Burke Co., Constr. Engrs. Refers to C. L. Allen, C. M. Cade.

OGLESBY, CLARKSON HILL, Phoenix, Ariz. (Age 27.) Refers to E. L. Grant, R. A. Hoffman, W. R. Hutchins, E. V. Miller, A. S. Niles, L. B. Reynolds, J. B. Wells.

OLDER, CLIFFORD DEWILTON, Wilmette, Ill. (Age 27.) Refers A. H. Fuller, W. E. Galligan, J. H. Griffith, F. Kerekes, L. R. Quayle, L. O. Stewart.

OSBORNE, GIFFORD LAWSON, Cathlamet, Wash. (Age 38.) County Engr., Wahkiakum County, Wash., and City Engr., Cathlamet. Refers to W. G. Brown, E. C. Dohm, L. V. Murrow, H. E. Newell, R. K. Tiffany.

PALANGE, RALPH CARMEN, Somerville, Mass. (Age 25). Refers to H. P. Burden, F. N. Weaver.

PAPAKYRIAZIS, DEMETRIUS GEORGE, Lake Geneva, Wis. (Age 25.) Refers to E. D. Roberts, F. W. Ullius.

PARK, LOUIS, Wolftown, Va. (Age 24.) Jun. Engr., U. S. Govt. Resettlement Administration, Washington, D.C. Refers to A. N. Johnson, S. S. Steinberg.

PERKINS, CHARLES ALVIN, Berkeley, Calif. (Age 24.) Refers to C. G. Hyde, B. Jameyson, G. E. Troxell.

PETERSON, ALTON HAWS, Mendon, Utah. (Age 22.) Rodman, U. S. Bureau of Reclamation. Refers to G. D. Clyde, O. W. Israelsen, H. R. Kepner.

PHILLIPS, ORLEY OLIVER, Colorado Springs, Colo. (Age 32.) Asst. Engr., City of Colorado, Springs, Colo. Refers to C. H. Bryson, G. M. Bull, M. C. Hinderlider, C. O. Lasley, B. Lowther, E. L. Mosley, F. M. Okey, F. O. Ray.

POPE, THOMAS FLINT, Winchester, Ill. (Age 32.) Jun. Highway Engr., State Highway Dept. Refers to W. A. Oliver, T. C. Shedd.

PORGES, RALPH, Greensboro, N.C. (Age 24.) Asst. Investigator, Textile Foundation, Experimental Plant. Refers to H. N. Lendall, W. Rudolfs.

PRACY, GEORGE WESLEY, Jr., San Francisco, Calif. (Age 22.) Refers to E. S. Borgquist, F. C. Kelton, J. C. Park, G. W. Pracy.

PRANGE, ROBERT LOUIS, St. Louis, Mo. (Age 20.) Draftsman (railroad drafting), Ramapo Ajax. Refers to C. E. S. Bardsley, J. B. Butler, E. W. Carlton, E. G. Harris.

PRITCHARD, ELMER MARION, Brownwood, Tex. (Age 27.) Refers to J. T. L. McNew, J. J. Richey.

QUACKENBUSH, CORNELIUS BOGERT, Hackensack, N.J. (Age 22.) Refers to H. G. Payrow, C. H. Sutherland.

RANDALL, THOMAS DUDLEY, Johnstown, N.Y. (Age 23.) Refers to R. W. Abbett, R. A. Hall, A. deH. Hoadley, W. C. Taylor.

REED, BERTRAM EULO, Fairfax, Va. (Age 44.) Assoc. Engr., Inspection Div., PWA, Washington, D.C. Refers to S. C. Dreyfus, F. O. Dufour, S. S. Kaler, E. J. Newton, C. S. Nichols, F. H. Shaw, V. B. Siems, W. L. Winters.

RETTIG, LARS ERIK, Ancon, Canal Zone. (Age 37.) Engr., U. S. Dept. Engr.'s Office, Corozal, Canal Zone. Refers to H. G. Arango, T. J. Butler, A. G. Holt, R. C. Jones, K. C. McFarland, E. S. Randolph.

RICE, CLARENCE WASHINGTON, Jr., Columbia, S.C. (Age 20.) Laboratory Asst. with J. S. Williamson. Refers to E. L. Clarke, D. D. Curtis.

RIST, LAWRENCE MAXWELL, Omaha, Nebr. (Age 27.) Inspector with U.S. Engr. Dept. Refers to E. S. Blaine, M. I. Evinger, D. H. Harkness, H. J. Kesner, C. E. Mickey.

ROCHE, PRESTON, Swarthmore, Pa. (Age 21.) Refers to E. M. Bassett, S. B. Lilly.

ROCKWOOD, HENRY, Washington, D.C. (Age 26.) Jun. Hydr. Engr., Sec. of Watershed Studies, Soil Conservation Service. Refers to M. Bernard, D. M. Corbett, C. S. Jarvis, H. B. Kinnison, C. E. Ramser.

ROOSE, MANLEY ALLYN, Chattanooga, Tenn. (Age 23.) Under Eng. Aide, Eng. Service Div., TVA, Chattanooga, Tenn. Refers to R. B. Kittredge, E. L. Waterman.

RYAN, GEORGE ALOYSIUS, Brooklyn, N.Y. (Age 24.) Refers to H. P. Hammond, L. F. Rader.

SANGER, FREDERICK JAMES, Shanghai, China. (Age 30.) Head of Dept. of Eng. & Bldg., Lester School & Henry Lester Inst. of Technical Education, Shanghai, China. Refers to H. Berents, J. A. Ely, S. E. Faber, E. H. King, Jr., G. H. Lundgren.

SAUNDERS, EDWARD WATTS, Charlottesville, Va. (Age 41.) Prof. of Applied Mathematics and Prof. of Civ. Eng., Univ. of Virginia. Refers to R. B. H. Begg, B. Burnley, J. L. Newcomb, W. D. Tyler, L. H. Williamson.

SCHWARTZ, JACK WILLIAM, Hollywood, Calif. (Age 21.) Refers to R. R. Martel, W. W. Michael, F. Thomas.

SENESI, JOHN JOSEPH, Brooklyn, N.Y. (Age 24.) Refers to F. A. Barnes, P. H. Underwood, C. L. Walker.

SESSUMS, ROY THOMAS, Ruston, La. (Age 28.) Refers to G. N. Cox, B. W. Pegues, F. F. Pillet.

SHALER, CLAIR ALFRED, Adrian, Mich. (Age 23.) Refers to C. L. Allen, F. R. Theroux.

SHURTZ, WARD HAYNES, Holdrege, Nebr. (Age 22.) Jun. Instrumentman, The Central Nebraska Public Power & Irrigation Dist., Hastings, Nebr. Refers to M. W. Furr, R. O. Green, R. F. Morse.

SIEG, JACK GEORGE, Tulsa, Okla. (Age 21.) Laborer, Hydr. Sec., U. S. Engr. Office, Rock Island, Ill. Refers to A. H. Holt, J. W. Howe, B. J. Lambert, E. L. Waterman.

SIMONS, EDWARD GORDON, Chicago, Ill. (Age 22.) Refers to J. J. Doland, W. A. Oliver.

SLOAN, EARLE STEPHEN, Stanford University, Calif. (Age 23.) Refers to E. C. H. Bantel, J. A. Focht, E. L. Grant, A. S. Niles, L. B. Reynolds.

SMITH, GEORGE ROBERT, Ottawa, Kans. (Age 26.) Engr. and Tech Foreman, U. S. Dept. of Agriculture Soil Conservation Service, ECW. Refers to W. C. McNown, C. C. Martin.

SOMAN, ROBERT, Forest Hills, N.Y. (Age 20.) Refers to E. N. Burrows, F. J. Seery.

STALLWORTH, THOMAS WILLIAM, Lufkin, Tex. (Age 25.) Asst. Office Engr., Div. Plans Office, Texas State Highway Dept. Refers to T. E. Huffman, V. G. Koch, L. B. Ryon, Jr., L. V. Uhrig, W. E. White.

STEELE, FRANCIS WARREN, Washington, D.C. (Age 24.) Refers to E. R. Cary, A. Haertlein, T. R. Lawson.

SULLIVAN, CHARLES WILLIAM, Oklahoma City, Okla. (Age 22.) Refers to L. M. Bush, J. E. Kirkham.

SULLIVAN, EUGENE BINGHAM, East Hartford, Conn. (Age 28.) Senior Engr. Aid on Middletown Portland Bridge, Connecticut State Highway, Hartford, Conn. Refers to L. H. Beebe, H. W. Buck, C. T. Morris, J. C. Prior, C. E. Sherman.

SUNDA, ADOLPH GEORGE, Montgomery, Ala. (Age 23.) Refers to G. J. Davis, Jr., D. C. A. du Plantier, J. S. Leister.

SWANNACK, GEORGE ERNEST, Jr., East Farms, Wash. (Age 20.) Refers to H. E. Phelps, M. K. Snyder, J. G. Woodburn.

SWATY, (Miss) VIRGINIA ADELINE, Cleveland Heights, Ohio. (Age 22.) Refers to E. F. Berry, L. Mitchell, S. D. Sarason, D. Y. Swaty.

THOMPSON, ARTHUR ROY, Reno, Nev. (Age 38.) Engr. Examiner, PWA for Nevada. Refers to H. P. Boardman, C. L. Hill, G. W. Malone, A. N. Thompson, W. R. Young.

TRAINER, WYATTE GRISTIE, Taft, Texas. (Age 20.) Rodman, Texas Highway Dept. Refers to J. T. L. McNew, J. J. Richey, C. E. Sandstedt.

TREXEL, CARL ALVIN, Washington, D.C. (Age 44.) Commander, C.E.C., U. S. Navy, Bureau of Yards and Docks, Navy Dept. Refers to R. E. Bakenhus, C. H. Cotter, E. R. Gayler, L. E. Gregory, J. T. Mathews, B. Moreell, A. L. Parsons, R. M. Warfield, D. C. Webb.

TRIBBLE, JOHN FURMAN, Birmingham, Ala. (Age 36.) Materials Engr., Alabama Highway Dept. Refers to C. A. Baughman, H. D. Burnum, J. A. C. Callan, W. Finnell, H. H. Houk, R. D. Jordan, J. H. Mayer.

TRUDE, WILLIAM CHARLES, Jr., Rea, Idaho. (Age 22.) Rodman, Upper Snake River Project, U. S. Bureau of Reclamation. Refers to J. E. Buchanan, I. N. Carter, I. C. Crawford, J. W. Howard.

TURNER, CULLEN YATES, Ft. Worth, Tex. (Age 22.) Office Asst., Acting as Inspector, Texas State Highway Dept., Div. No. 2. Refers to F. E. Lovett, M. E. Worrell.

TWEEDY, EDWIN STEPHEN, Richmond Hill, N.Y. (Age 31.) Constr. Mgr., Diocesan Bldg., Comm., Brooklyn, N.Y. Refers to F. E. Foss, S. Negrey, C. T. Schwarze, F. N. Severud, L. W. Weed.

VANDEN BERG, JOHN LLOYD, McGehee, Ark. (Age 26.) Transitman, Resettlement Administration. Refers to H. F. Bucher, J. C. Pinney, W. C. Polkinghorne, J. R. Rhyne.

VAN HAGAN, CHARLES EDWARD, Madison, Wis. (Age 22.) Refers to H. F. Janda, L. F. Van Hagan.

VAN NEST, PAUL WANAMAKER, Elizabeth, N.J. (Age 22.) Refers to F. A. Barnes, S. C. Hollister, E. R. Needles, J. E. Perry, C. L. Walker.

WALLER, ARTHUR CANNING, Boise, Idaho. (Age 48.) Materials & Oiling Engr., Idaho Bureau of Highways in charge of Materials Laboratory, Boise, and of highway work in Road Materials Laboratory, Univ. of Idaho. Refers to J. E. Buchanan, I. C. Crawford, H. W. Gregory, W. P. Hughes, H. S. Kerr, F. L. McAtee, B. W. Matteson, R. M. Miller, R. R. Mitchell, L. V. Murrow, J. W. Powers.

WALTHALL, JOSEPH EDWARD, Jr., Moreland, Ga. (Age 23.) Refers to R. P. Black, F. C. Snow.

WARLAM, ARPAD ANTAL, Budapest, Hungary. (Age 27.) Asst., Royal Hungarian Technical Univ. Refers to A. Haertlein, G. E. Hawthorn, R. G. Hennes, L. V. Murrow, R. G. Tyler.

WARNER, RAYMOND ALOYSIUS, Dearborn, Mich. (Age 35.) Asst. Res. Engr. Inspector, PWA. Refers to E. L. Eriksen, C. C. Johnston, W. J. Lehner, M. P. Ohr, C. J. J. Pajot, F. R. Storrer.

WEBB, WALLACE WARREN, South Otselic, N.Y. (Age 22.) Chainman and Rodman, Chenango County Highway Dept. Refers to W. H. Allison, W. J. Farrisee, F. C. Wilson.

WEINBERG, DAVID, SHERIDAN, Wyo. (Age 30.) Refers to C. L. Eckel, E. W. Raeder.

WHITNEY, SCHUYLER ALLEN, TROY, N.Y. (Age 21.) Refers to T. R. Lawson, H. O. Sharp.

WIGGINS, BENN ALBERT, Montour Falls, N.Y. (Age 23.) Asst. Engr. and Foreman, Schuyler County Highway Dept. Refers to W. J. Farrisee, F. C. Wilson.

WINEY, ARTHUR HENRY, Fanwood, N.J. (Age 22.) Refers to D. M. Griffith, O. L. King.

WOLF, WILLIAM HENRY, Leadville, Colo. (Age 22.) Refers to R. L. Downing, C. L. Eckel.

WU, HANG-MIEN, Ann Arbor, Mich. (Age 24.) Refers to W. J. Emmons, W. C. Hoad, H. W. King, R. L. Morrison, R. H. Sherlock, C. O. Wisler.

YANCHEWSKI, LUDWIG ADAM, New York City. (Age 20.) Refers to L. V. Carpenter, C. T. Schwarze.

YOKOTA, GEORGE JOHN, New York City. (Age 20.) Refers to R. C. Brumfield, F. E. Foss, G. Morrison.

FOR TRANSFER

FROM THE GRADE OF ASSOCIATE MEMBER

ARCHIBALD, RAYMOND, Assoc. M., San José, Costa Rica. (Elected Oct. 26, 1931.) (Age 40.) Constr. Engr., U. S. Bureau of Public Roads. Refers to N. B. Garver, D. A. MacCrea, C. B. McCullough, H. P. Mobberly, E. C. Panton, G. S. Paxton, R. B. Wright, W. W. Zass.

BOWLUS, FRED DREXEL, Assoc. M., Whittier, Calif. (Elected Junior Sept. 3, 1913; Assoc. M. Dec. 6, 1915.) (Age 50.) Res. Engr., Los Angeles County San. Dists., Los Angeles, Calif. Refers to H. F. Blaney, F. E. Bonner, F. H. Fowler, A. Jones, A. M. Rawn, A. K. Warren, H. E. Warrington.

CARLTON, ERNEST WILSON, Assoc. M., Rolla, Mo. (Elected June 10, 1929.) (Age 39.) Associate Prof. of Civ. Eng., Missouri School of Mines. Refers to C. E. S. Bardsley, H. C. Beckman, C. W. Brown, J. B. Butler, E. G. Harris, H. K. Rubey, E. O. Sweetser.

CILLEY, MORGAN, Assoc. M., Romney, W.Va. (Elected Nov. 8, 1909.) (Age 58.) In private practice. Refers to J. W. Beardsley, E. C. Blosser, E. R. Frisby, E. W. James, F. D. Nash, C. T. Schwarze, E. P. Shuman, F. F. Skinner, C. Swecker, E. Welle.

FRENCH, FRANK STURGILL, Assoc. M., Austin, Tex. (Elected Aug. 18, 1930.) (Age 35.) Chf. Valuation Engr., Utilities and Oil Pipe Line Divs., Railroad Comm. of Texas. Refers to H. E. Elrod, S. W. Freese, C. S. Lambie, R. L. Lowry, Jr., J. Montgomery, M. C. Nichols, E. A. Wood.

HARRIS, CLINTON LEE, Assoc. M., State College, Pa. (Elected Aug. 28, 1922.) (Age 50.) Prof. of Architectural Eng., Pennsylvania State Coll. Refers to P. B. Breneman, R. A. Caughey, O. J. Marsten, W. P. Rothrock, R. L. Sackett, E. D. Walker.

HEDGER, HAROLD EVERETT, Assoc. M., Glendale, Calif. (Elected April 18, 1927.) (Age 37.) Asst. Chf. Engr. Los Angeles County Flood Control Dist., Glendale, Calif. Refers to M. Butler, O. F. Cooley, S. V. Cortelyou, C. H. Howell, D. A. Lane, J. O. Marsh, A. M. Rawn.

ODESSEY, HERMAN PAUL, Assoc. M., Norfolk, Va. (Elected Junior May 8, 1922; Assoc. M. July 16, 1928). (Age 38.) Commanding Officer, S.S. Gilbert, U. S. Coast and Geodetic Survey, Washington, D.C. Refers to W. Bowie, G. D. Cowie, F. G. Engle, R. S. Patton, R. L. Schoppa, H. A. Seran, F. B. T. Siems.

WEAVER, FREDERIC NIXON, Assoc. M., Medford Hillside, Mass. (Elected Oct. 12, 1925.) (Age 46.) Prof. of Civ. Eng., Tufts Coll., Tufts College, Mass. Refers to H. P. Burden, R. H. Cameron, H. A. Gray, J. W. Howe, E. L. Moreland, E. H. Wright.

WHITTELSEY, CHARLES CHAUNCEY, Assoc. M., Monroe, La. (Elected Junior July 16, 1923; Assoc. M. Oct. 14, 1930.) (Age 35.) Staff Engr. with Ford, Bacon & Davis, Inc., New York City. Refers to E. S. Bres, S. E. Huey, G. I. Rhodes, G. H. Sager, Jr., F. J. Treisace W. von Phul.

FROM THE GRADE OF JUNIOR

ALLEN, MARK LAWRENCE, Jun. Huntington, W. Va. (Elected Oct. 26, 1931.) (Age 27.) Jun. Engr., U. S., Engr. Dept., Huntington Dist., Huntington, W.Va. Refers to H. C. Corns, C. W. Granacher, C. B. Jansen, J. H. C. Sprague, E. E. Teeter.

BACK, NICHOLAS VALENTINE, Jun., Philadelphia, Pa. (Elected March 14, 1927.) (Age 32.) Designer, New York Central R.R. Refers to J. H. Angen, F. L. Castleman, A. M. Nelson, J. E. Porter, E. D. Walker, H. T. Welty.

BOWMAN, FREDERIC BERKELEY, Jun., Denver, Colo. (Elected Dec. 26, 1934.) (Age 32.) Asst. Engr., Canals Div., U. S. Bureau of Reclamation. Refers to F. D. Bowlus, H. R. McBirney, D. G. O'Shea, M. K. Snyder, F. Thomas, H. L. Thompson.

BROWN, CHARLES REED, Jun., Ft. Peck, Mont. (Elected Feb. 19, 1934.) (Age 33.) Associate Engr., U. S. Engrs., being chief of supply Sec. Ft. Peck Office. Refers to O. G. Baxter, F. J. Brown, T. B. Larkin, E. G. Plank, L. F. Reynolds, N. T. F. Stadtfeld, K. R. Young.

CARTER, GEORGE RICHMOND, Jun., Marion, Ill. (Elected Oct. 30, 1933.) (Age 28.) Camp Engr., Soil Conservation Service. Refers to A. A. Brielmaier, H. Cross, M. M. Hughes, W. C. Huntington, T. C. Shedd.

DEWEESE, OMER LYNN, Jun., Evansville, Ind. (Elected Feb. 27, 1933). (Age 32.) Chf. of Survey Party, State Highway Comm., Indianapolis, Ind. Refers to A. A. Cummins, C. M. DuBois, J. T. Hallett, F. Kellam, J. W. Wheeler, H. L. White, N. F. Williams.

EBERZ, FRED LUDWIG, Jun., Washington, D.C. (Elected Oct. 1, 1928.) (Age 31.) Asst. Structural Engr., Public Works Branch, Procurement Div., Treasury Dept. Refers to H. L. Bowman, J. W. Dunham, J. H. Eaton, C. A. Emerson, Jr., P. J. Hale, H. G. Perring.

FROGGATT, WILFRID ARMOUR, Jun., San Francisco, Calif. (Elected Jan. 16, 1928.) (Age 32.) With H. L. Haehl, Civ. Engr. Refers to E. E. Blackie, B. A. Etcheverry, H. L. Haehl, E. F. Levy, R. Matthew, W. Ruppel, F. H. Tibbetts.

GRUNWELL, GILBERT BUTTERFIELD, Jun., Washington, D.C. (Elected Dec. 23, 1932) (Age 32.) Jun. Topographic Engr., U. S. Geological Survey. Refers to G. H. Barton, S. A. Becker, T. Human, Jr., G. C. Mattison, G. S. Smith, R. M. Wilson, W. L. Wilson.

HARDER, BERNARD SAMUEL, Jun., Los Angeles, Calif. (Elected Dec. 9, 1935.) (Age 31.) Asst. Res. Engr., Bridge Dept., State of California. Refers to G. F. Nicholson, H. K. Palmer, F. W. Panhorst, A. M. Rawn, D. R. Warren, H. E. Warrington, P. R. Watson.

HEDEFINE, ALFRED, Jun., Kearny, N.J. (Elected Jan. 26, 1931.) (Age 30.) Designer and Detailer, Waddell & Hardesty. Refers to F. De Schauensee, S. Hardesty, E. L. Macdonald, E. R. Needles, E. Praeger, J. A. L. Waddell, W. M. Wilson.